**Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World**

**Unit 3: Adapt or Die?**

**Essential Question:** Why do species change over time and should we intervene?

**Total Number of Instructional Days**: 25 - 29

**Unit 3 Pop-Out**

Right, Wrong, and In-Between

(*Implement any time after Task 4*)

**Group Culminating Project:**

“Think Tank” Discussion: For species affected by a human-caused environmental change, should we intervene or let nature take its course?

**Individual Culminating Project**

Post-Discussion Report

**Lift-Off Task:**

The Case of the Peppered Moths

**Task 1:**

The Fossil Record and Geologic Time Scale

**Task 2:**

Evidence of Change Over Time

**Task 3:**

Natural Selection

Connect to the Culminating Project using the Project Organizer

**Task 4:**

Human Intervention

**Storyline for Unit 3**

In this unit, students will be exploring how species change over time, as well as the various pieces of evidence that exist to document this change over time. The Lift-Off Task hooks students with the classic case of the Peppered Moth, which is a great case to study because the change was human-caused and dramatic since it happened so rapidly. In this Lift-Off Task, students draw on their prior knowledge to generate questions about the phenomenon of the changing Peppered Moth. These student-generated questions will guide their learning throughout this unit.

Over the course of this unit, students will learn that many more species are also being affected by changes in their environment as a result of human activity. As we watch more and more species struggle with the changing environmental conditions, the question for their culminating project becomes: Should we intervene or allow nature to take its course? After the Lift-Off task, student groups will select one species that is negatively affected by human-caused changes in their environment, which will serve as the focus for their culminating project.

While in the last task, students saw a specific example of one species changing over time, Task 1 asks them to take a step back by looking at the evidence we have that all species have changed over Earth’s long history and why. In order to do this, they explore the fossil record and how scientists have organized Earth’s 4.6 billion-year-old history into the geologic time scale. This serves as the foundation for them to consider how the kind of environmental change that is happening now has happened in the past. Students find that we can learn from the fossil record and past incidents of climate change to predict how current environmental change will affect species in our world today.

In Task 2, students continue their reconstruction of evolutionary history, by looking at two more kinds of evidence that scientists use to infer lines of evolutionary descent: anatomical structures and embryos of different organisms. By the end of this task, students will be able to construct an explanation for how scientists are able to reconstruct evolutionary history, using these examples as evidence to support their explanation. This adds another layer to the story students are constructing about how species change over time, thus better preparing them for their culminating project.

In Task 3, students return to many of the questions they generated about the Peppered Moths in the Lift-Off Task, by zooming in on the process that makes this case possible. Students engage in a simulation of natural selection, generating data they can use to mathematically calculate the percentages of different traits. By identifying trends in the data, they will be able to explain how natural selection may lead to increases and decreases of specific traits in populations over time, pinpointing the process that is changing species as a result of environmental change.

Up until this point, students will have focused on how species naturally change over time, but these changes are not always completely natural. In this final task, students explore ways in which humans have intervened in these natural processes through selective breeding and genetic engineering. Understanding these processes will be essential to the question in their culminating project of whether to intervene or not.

Once students complete all the tasks, they continue their research of a species affected by changing environmental conditions caused by human activity. Using what they have learned throughout the unit, they decide whether humans should intervene to save this species or not and develop an argument to support their position in a Think Tank Discussion. After the discussion, students individually write a Post-Discussion Report, detailing the scientific background on their own species as well as their argument, using the discussion as additional evidence and reasoning.

**Three-Dimensional Breakdown of the Performance Expectations**

This unit was developed to align with, teach, and assess students’ understanding and skills related to these Performance Expectations. Below, we have mapped out the disciplinary core ideas, crosscutting concepts, and science and engineering practices addressed in this unit. Aspects of the dimensions that are not explicitly addressed in this unit are crossed out.

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| **Performance Expectations** | **Science and Engineering Practices** | **Disciplinary Core Ideas** | **Crosscutting Concepts** |
| **MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history.**[Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth’s history. Examples of Earth’s major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [*Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.*] | **Constructing Explanations and Designing Solutions** Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. | **ESS1.C: The History of Planet Earth** The geologic time scale interpreted from rock strata provides a way to organize Earth’s history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. | **Scale, Proportion, and Quantity**   * Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.   **Stability and Change**   * Stability might be distributed either by sudden events or gradual changes that accumulate over time. (*Supplementary)* |
| **MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.** [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [*Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*] | **Developing and Using Models**   * Develop and use a model to describe phenomena. | **LS3.A Inheritance of Traits**   * Genes are located in the chromosomes of cells~~, with each chromosome pair containing two variants of each of many distinct genes~~. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.   **LS3.B: Variation of Traits**   * In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. | **Structure and Function**   * Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. |
| **MS-LS4-1. 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.] | **Analyzing and Interpreting Data**   * Analyze and interpret data to determine similarities and differences in findings. | **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 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. | **Patterns**   * Graphs, charts, and images can be used to identify patterns in data.   **Stability and Change**   * Stability might be distributed either by sudden events or gradual changes that accumulate over time. (*Supplementary)* |
| **MS-LS4-2. 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: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.] | **Constructing Explanations**   * Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. | **LS4.A: Evidence of Common Ancestry and Diversity**   * 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. | **Patterns**   * Patterns can be used to identify cause-and-effect relationships. |
| **MS-LS4-3.  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.] | **Analyzing and Interpreting Data**   * Analyze displays of data to identify linear and nonlinear relationships. | **LS4.A: Evidence of Common Ancestry and Diversity**   * Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. | **Patterns**   * Graphs, charts, and images can be used to identify patterns in data. |
| **MS-LS4-4.  Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some 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.] | **Constructing Explanations**   * Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. | **LS4.B: Natural Selection**   * Natural selection leads to the predominance of certain traits in a population, and the suppression of others. | **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-LS4-5. 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. | **Obtaining, Evaluating, and Communicating Information**   * Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s). | **LS4.B. Natural Selection**   * 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. | **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-LS4-6.  Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of 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.*] | **Using Mathematics and Computational Thinking**   * Use mathematical representations to support scientific conclusions and design solutions. | **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 distribution of traits in a population changes. | **Cause and Effect**   * Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. |

**Connections to Common Core Math and ELA Standards:**

Over the course of this unit, students will gain knowledge and skills in science, as well as in math and English-language arts. Below we list the Common Core ELA and Math standards for middle school and 8th grade that are relevant to the curriculum tasks in this unit. Within the curriculum, there are opportunities to incorporate components of the following ELA and Math Standards:

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| **Middle School Common Core ELA Standards** | | **Unit Task** |
| **Key Ideas and Details** | CCSS.ELA-Literacy.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. | Task 1 |
| **Craft and Structure** | CCSS.ELA-Literacy. RST. 6-8.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*. | Task 1  Task 2  Task 3  Task 4 |
| **Integration of Knowledge and Ideas** | CCSS.ELA-Literacy.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). | Task 1  Task 3  Task 4 |
| CCSS.ELA-Literacy.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. | Task 1  Task 4 |
| **Research to Build and Present Knowledge** | CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research. | Task 1  Task 2 |
| **Comprehension and Collaboration** | CCSS.ELA-Literacy.SL.8.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. | All Tasks  Culminating Project |
| **Presentation of Knowledge and Ideas** | CCSS.ELA-Literacy.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. | Culminating Project |
| CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. | Task 4 |

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| **Middle School and 8th Grade Common Core Math Standards** | | **Unit Task** |
| **Mathematical Practice** | CCSS.MATH.MP.4: Model with mathematics. | Task 1  Task 3 |

**Connections to English Language Development (ELD) Standards:**

We acknowledge that language development is a key component of disciplinary understanding and helps to support more rigorous and equitable outcomes for diverse students. This curriculum thus takes into account both the receptive and productive language demands of the culminating projects and strives to increase accessibility by including scaffolds for language development and pedagogical strategies throughout learning tasks. We aim to support language acquisition through the development of concept maps; utilizing sentence frames; implementing the Critique, Clarify, Correct technique; employing the Stronger Clearer strategy; and fostering large and small group discussions.

The California ELD Standards are comprised of two sections: the standards and a rubric. Outlined below are the standards from Section One that are met within this curriculum. For additional information, please refer to: https://www.pausd.org/sites/default/files/pdf-faqs/attachments/SS\_ELD\_8.pdf.

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| **Eighth Grade ELD Standards** | | |
| **Part I: Interacting in Meaningful Ways** | A: Collaborative | 1.Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics |
| 2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia) |
| 3. Offering and justifying options, negotiating with and persuading others in communicative exchanges |
| 4. Adapting language choices to various contexts (based on task, purpose, audience, and text type) |
| B: Interpretive | 5. Listening actively to spoken English in a range of social and academic contexts |
| 6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language |
| 7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area |
| 8. Analyze how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area |
| C: Productive | 9. Expressing information and ideas in formal oral presentations on academic topics |
| 10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology |
| 11. Justifying own arguments and evaluating others’ arguments in writing |
| 12. Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas |
| **Part II: Learning About How English Works** | A: Structuring Cohesive Texts | 1. Understanding text structure |
| 2. Understanding cohesion |
| B: Expanding and Enriching Ideas | 3. Using verbs and verb phrases |
| 4. Using nouns and noun phrases |
| 5. Modifying to add details |
| C: Connecting and Condensing Ideas | 6. Connecting ideas |
| 7. Condensing ideas |

**Connections to Environmental Awareness:**

Over the course of this curriculum, students will explore content related to various environmental principles and concepts that examine the interactions and interdependence of human societies and natural systems. In accordance with the *Education and the Environment Initiative (EEI),* tasks throughout this curriculum explore many of *California’s Approved Environmental Principles and Concepts.* The principles relevant to this unit are outlined in the chart below:

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| **Unit Task** | **EEI Principle** | **EEI Concept** |
| Culminating Project  Lift-Off Task  Task 3: Natural Selection | Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies. | Concept A: Students need to know that direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems. |
| Culminating Project  Lift-Off Task  Task 3: Natural Selection  Task 4: Genetic Engineering | Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both. | Concept B: Students need to know that the byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect. |
| Concept C: Students need to know that the capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity and the nature of its byproducts. |