California Education and the Environment Initiative

The EEI Curriculum cohesively integrates science and engineering practices (SEPs), content (disciplinary core ideas/DCIs), and crosscutting concepts (CCs) within its lesson procedures. This preliminary analysis intentionally teases apart the individual SEPs, DCIs, and CCs as a means of correlating the EEI unit with specific performance expectations; however, the EEI lessons weave these components back together to provide three-dimensional learning for students.

High School Life Science

B.5.c. - High Tech Harvest: Genetic Engineering and the Environment

"High Tech Harvest: Genetic Engineering and the Environment" provides students with an in-depth look at the inheritance and variation among traits using both plants and animals. The unit explores these topics by examining "golden rice", BT corn, bacteria that are used to produce biofuels, and other genetically modified organisms. Through this unit, students examine the history of genetic engineering in California, learn about both traditional and modern methods of genetic engineering, and discover how "human-directed" modification of plants and animals can influence both natural systems and human health. By studying the potential influence of "super rice" on natural systems, they ascertain how organisms that have been genetically modified by humans can affect biological evolution and biodiversity. Finally, students examine the factors that are considered while making decisions about engineering solutions, such as genetically modified organisms.

Next Generation Science Standards* Correlation with the California Education and the Environment Initiative (EEI) Curriculum

The EEI Curriculum is a great choice for transitioning to NGSS and contributes toward achievement of the performance expectations for the standards reflected in the Summary Chart below: HS-LS3 Heredity: Inheritance and Variation of Traits, HS-LS4 Biological Evolution: Unity and Diversity, HS-ESS3 Earth and Human Activity, and HS-ETS1 Engineering Design. Each EEI unit highlights a small number of performance expectations, science and engineering practices, disciplinary core ideas, and crosscutting concepts. Therefore, the EEI units contribute to students' overall achievement of the performance expectations by the end of a school year, where they will have had multiple opportunities to engage in all appropriate science and engineering practices, disciplinary core ideas, and crosscutting concepts. While EEI was designed to teach the 1998 California science standards to mastery, it reflects the real world interconnections in science and already incorporates many of the paradigm shifts reflected in the NGSS. To learn more about how EEI supports NGSS, visit http://californiaeei.org/NGSSGuides/.

	Next Generation Science Standards											
	HS-LS3			HS-LS4			HS-ESS3			HS-ETS1		
California Connection		✓	✓		✓	✓		✓	✓		✓	
Lesson 1 - Examine the history of genetically engineered rice in California.	✓	✓	✓	✓		✓	✓	✓	✓		✓	
Lesson 2 - Explore how traditional and modern forms of genetic engineering work.	✓	✓		✓				✓	✓		✓	
Lesson 3 -Identify how genetically modified products can influence natural systems and human health.	✓	✓	✓	✓	✓	✓		✓		✓	✓	
Lesson 4 -Discover the range of influences genetically engineered products can have.	✓	✓	✓	✓	✓	✓		✓		✓	✓	
Lesson 5 -Examine how super rice has influenced natural systems.	✓		✓	✓	✓	✓		✓	✓	✓	✓	
Lesson 6 -Analyze the factors involved in decisions about genetically engineered products.	✓			✓				✓			✓	
Traditional Unit Assessment	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Alternative Unit Assessment	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
	SEP	DCI	CC	SEP	DCI	CC	SEP	DCI	CC	SEP	DCI	CC

Correlation Chart Key

SEP (Science and Engineering Practices)
DCI (Disciplinary Core Ideas)
CC (Crosscutting Concepts)

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EEI Unit B.5.c. - High Tech Harvest: Genetic Engineering and the Environment

Disciplinary Core Ideas Supported by this EEI Unit

HS-LS3 Heredity: Inheritance and Variation of Traits
HS-LS4 Biological Evolution: Unity and Diversity
HS-ESS3 Earth and Human Activity
HS-ETS1 Engineering Design

Performance Expectations	Suggestions for Using the EEI Unit to Support NGSS
HS-LS3-2: Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.	Use the unit to have students examine evidence from a study of genetically-modified organisms (GMOs), such as plants that are used for agricultural purposes, to determine if the genetic materials in the GMOs can be introduced into other varieties or species thereby introducing genetic variations into those organisms. Have them consider evidence about how these changes can result in mutations to non-genetically modified plants of the same species, as the result of environmental factors including the cross-pollination of plants caused by environmental conditions such as crop proximity and pollen that is carried by insects or wind.
HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	Use the unit to have students evaluate evidence related to GMOs, to examine the cause and effect relationships between the environmental changes that may result from the use of GMOs, and the emergence of new species or the extinction of other species over time.
HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	Use this unit to help students understand the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Using information acquired in this unit, students will have the background knowledge with which to create a computational simulation that shows the relationship between the human use of genetically modified crops and the possible effects on plant biodiversity.
HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	Use this unit to have students examine how science can be used to evaluate many possible solutions to real-world problems, such as the use of GMOs to improve global health and the human food supply, and that engineered solutions often may have both intended and unintended consequences that affect Earth's natural systems, as well as human health, the economy, and other human systems.

Science and Engineering Practices (SEPs)	Suggestions for Using EEI to Support SEPs	Disciplinary Core Ideas (DCIs)	Suggestions for Using EEI to Support DCIs	Crosscutting Concepts (CCs)	Suggestions for Using EEI to Support CCs
Engaging in Argument from Evidence (HS-LS3-2, HS-LS4-5)	Use the unit to have students gather information about a variety of GMOs and analyze how science and engineering influence the production of genetically-modified products (Lessons 1 and 2). Have them study information about specific genetically-engineered products to determine how those products might influence: natural systems, biological diversity, and human health (Lessons 3 and 4).	**LS3.B: Variation of Traits:** 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.	Use the unit to have students examine cross-pollination as they study the impacts of introducing genetically modified crops that create more genetic variation due to genetic contamination (Lessons 1, 2, 3, and 4).	**Cause and Effect (HS-LS3-2, HS-LS4-5)**	Use the unit to have students consider the differences between cause and correlation. Have them use the multiple cases of genetically-modified products presented to analyze available evidence and determine if the effects that are described have a direct and specific cause (such as cross-pollination being caused due to proximity of genetically modified crops, allowing wind and insects to carry pollen) or if they represent correlations

Science and Engineering Practices (SEPs)	Suggestions for Using EEI to Support SEPs	Disciplinary Core Ideas (DCIs)	Suggestions for Using EEI to Support DCIs	Crosscutting Concepts (CCs)	Suggestions for Using EEI to Support CCs
	Have students gather evidence and deliver arguments based on evidence associated with the economic, health, and environmental costs and benefits of genetically-engineered products (Lessons 5 and 6).	Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)			rather than causal relationships (such as the availability of data related to the effects of genetically-engineered products and the diversity of scientific and public opinion regarding GMOs) (Lessons 3, 4 and 5).
Using Mathematics and Computational Thinking **(HS-ESS3-3)**	Use the unit to have students evaluate the data presented on GMO crops and extrapolate how the number of genetically modified crops may increase in the future (Lesson 1).	**LS4.C: Adaptation:** Changes in 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. (HS-LS4-5)	Use the unit to have students examine how the distribution of traits in a population can change when conditions change, and how those changes can affect biodiversity (Lessons 3, 4, and 5).	**Stability and Change** **(HS-ESS3-3)**	Use the unit to have students consider evidence regarding the introduction of genetically-engineered products into ecosystems as it pertains to the stability of those natural systems and the rapidity and reversibility of the effects of GMOs on natural systems, biological diversity, and human health (Lessons 3 and 5).
Constructing Explanations and Designing Solutions **(HS-ETS1-3)**	Use the unit to have students evaluate the genetically-engineered products presented throughout this unit (to help solve real-world issues about food production and human health) and ask that students consider three or more aspects of those solutions such as cost, safety, reliability, and predicted environmental and human impacts (Lessons 3, 4, and 5).	**ESS3.C: Human Impacts on Earth Systems:** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)	Use the unit to have students explore the types and percentages of genetically modified crops grown (Lesson 1). Have them consider the potential impacts genetically modified crops have on humans and the environment (Lessons 2, 3, and 4). Have students examine the wide range of factors that should be considered when deciding whether to commercially introduce genetically-modified products where they might enter into and affect natural systems (Lessons 5 and 6).	**Influence of Engineering, Technology, and Science on Society and the Natural World.**	Use the unit to have students evaluate the importance of understanding and determining the potential impacts genetically engineered products can have on natural systems and to understand that there are some impacts that cannot be anticipated (Lessons 3, 4, 5, and 6).
Analyzing and Interpreting Data *(Not associated with a specific Performance Expectation)*	Use this unit to have students analyze available data (that could include statistics and probability) to make claims about GMOs and how they may influence natural systems (Lessons 3 and 4). Have students examine data and determine the costs, whether economic, health, or environmental, associated with the production and use of GMOs (Lessons 5 and 6).	**ETS1.B: Developing Possible Solutions:** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)	Use the unit to have students consider solutions proposed throughout this unit to help solve global health and food production concerns. Have them consider the multiple consequences of each solution, such as cost, safety, reliability, as well as their potential effects on natural and human social systems (All Lessons).		