

UNIT 3

Nature via Nurture

How can we use environmental and genetic factors to explain changes in organisms?

SCALE

Stanford Center for Assessment,
Learning & Equity



Sharing and Use

This curriculum was developed by the SCALE Science Team and is distributed under a "Creative Commons Attribution - NonCommercial 4.0 International License". This means that you are free to share and adapt these materials as long as you follow the following terms:

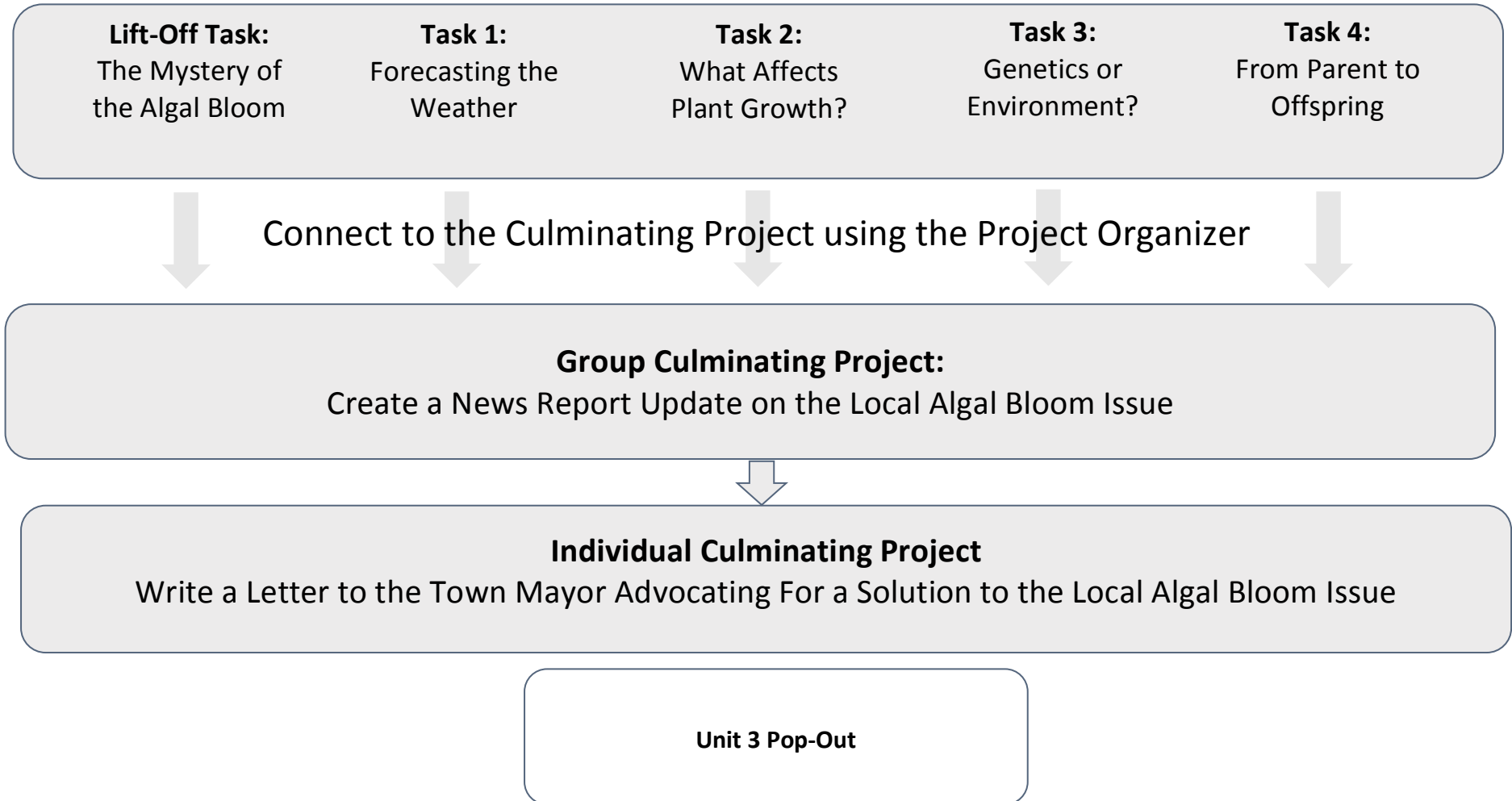
- Attribution - You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- NonCommercial — You may not use the material for commercial purposes.



Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World
Unit 3: Nature via Nurture

Essential Question: How can we use environmental and genetic factors to explain changes in organisms?

Total Number of Instructional Days: 26.5



6th Grade Science Unit 3: Nature via Nurture

Unit Overview

Storyline for Unit 3

Toxic algal blooms have become more and more common in recent years, making affected bodies of water dangerous to both humans and other organisms. In this unit, students explore why this might be the case and examine environmental causes, such as changing weather conditions, as well as any genetic factors that might be at play.

In the Lift-Off Task, students are introduced to one example, Lake Temescal in Oakland, which has been repeatedly closed due to recurring toxic algal blooms. By examining this phenomenon, students can begin to generate questions that help them better make sense of what is happening in all lakes. The questions they generate will guide them throughout the unit as they continue to make sense of algal blooms, their causes and consequences, and what can be done about them.

In Task 1, students begin to consider what causes these algal blooms and why they only happen in some years but not others. In order to explore these questions, students need to dig into weather. Using diagrams, simulations, videos, and weather maps, students investigate how the movement and interactions of air masses result in different weather conditions. Using this information, students are able to explain some possible causes for typical weather conditions experienced during years that result in toxic algal blooms.

In Task 2, students think about how changing weather conditions results in environment changes for all kinds of organisms who live in that region. Students investigate the question of whether environmental factors influence the growth of organisms, specifically plants. By identifying the cause-and-effect relationship between environmental change and growth of plants, they will be able to predict that algal blooms are also likely caused by environmental changes—increased temperature, increased rainfall, and excess fertilizer runoff—the latter of which is found through additional research.

In Task 3, students begin to consider that the environment might not be the only factor in play. After collecting an abundance of scientific evidence on the nature vs. nurture issue, students are able to return to explain that it is not an either-or question; in fact, both genetics and environment play a role in all organisms' growth. In the end of this task, students are given another piece of information that the gene for toxicity in algae has been identified, but is only present in some types of algae. Students are then poised to use all this information, including research from Task 2, to explain whether the toxic algal bloom in the local lake is caused by genetics or environment.

In Task 4, students learn what a genetic cause really means by modeling the processes that pass traits from parent to offspring—both sexual reproduction and asexual reproduction. In their kinesthetic and visual models, students find that sexual reproduction leads to offspring with genetic variation, while asexual reproduction does not. In the end, students will be able to explain how cyanobacteria (blue-green algae) inherit their traits and whether this process leads to more or less genetic variation in that species.

Once students have completed all tasks and their Project Organizers, they can begin work on their culminating project. Students have already been introduced to a local lake plagued by toxic algal blooms. Their culminating project is to figure out exactly why this is happening and what can be done—is it an environmental issue or has the algae itself actually changed? As a group, students will create a news story update on the local lake situation, sharing any new evidence they have uncovered and what this means. This can either be a video newscast or an article in the local newspaper. After presenting their news stories, each student will individually write a letter to the town's mayor, explaining the problem and advocating for a potential solution given what they know.

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**

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.

Performance Expectations	Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. <i>[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).]</i> <i>[Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]</i></p>	<p>Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. 	<p>ESS2.C: The Roles of Water in Earth’s Surface Processes</p> <ul style="list-style-type: none"> The complex patterns of the changes and the movement of water in the atmosphere determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> Because these patterns are so complex, weather can only be predicted probabilistically. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.
<p>MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. <i>[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed</i></p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> 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 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Genetic factors as well as local conditions affect the growth of the adult plant. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**

<p>cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]</p>	<p>world operate today as they did in the past and will continue to do so in the future.</p>		
<p>MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]</p>	<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop and use a model to describe phenomena. 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring (<i>secondary</i>). <p>LS3.A: Inheritance of Traits</p> <ul style="list-style-type: none"> Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. <p>LS3.B: Variation of Traits</p> <ul style="list-style-type: none"> In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**

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 6th 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:

Middle School and 6th Grade 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.	Task 3 Project
	CCSS.ELA-Literacy.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.	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 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 Project
	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 3 Task 4 Project
Research to Build and Present Knowledge	CCSS.ELA-Literacy.WHST.6-8.8: Gather relevant information from multiple print and digital sources, using search terms effectively.	Task 2 Project
	CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.	Task 1 Task 2 Task 3 Project
Presentation of Knowledge and Ideas	CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.	Project

Middle School and 6th Grade Common Core Math Standards		Unit Task
Mathematical Practice	CCSS.MATH.MP.2: Reason abstractly and quantitatively.	Task 1 Task 2 Task 3 Task 4 Project
	CCSS.MATH.MP.4: Model with mathematics.	Task 4
Summarize and Describe Distributions	CCSS.MATH.CONTENT.6.SP.B.5: Summarize numerical data sets in relation to their context.	Task 1 Task 2 Project

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**

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, Correct, Clarify 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_6.pdf.

6th 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. Analyzing 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

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**

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*. While none of the tasks explicitly address these *EEI* principles, the context of the project focuses on an environmental issue, as outlined in the chart below:

Unit Task	EEI Principle	EEI Concept
Lift-Off Task Project	Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.	Concept A: The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept B: The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept C: The quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Lift-Off Task Project	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: 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.
		Concept C: The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.
Lift-Off Task Project	Principle III: Natural systems change in ways that people benefit from and can influence.	Concept A: Natural systems proceed through cycles and processes that are required for their functioning.
		Concept C: Human practices can alter the cycles and processes that operate within natural systems.
Lift-Off Task Project	Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.	Concept A: The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.
		Concept B: 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: 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.

**6th Grade Science Unit 3: Nature via Nurture
Unit Overview**



Lift-Off Task Project	Principle V: Decisions affecting resources and natural systems are complex and involve many factors.	Concept A: There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.
-----------------------	--	---

6th Grade Science Unit 3: Nature via Nurture

Teacher Materials List

Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Overall Unit – All Tasks

- Unit 3, Task Cards Student Version, Lift-Off and Tasks 1 through 4
- Culminating Project Student Task Card
- Project Organizer
- Projector with Audio (for video or images, whenever needed)

Lift-Off Task (2 days, based on 45-minute periods)

Per Student

- Task Card Student Version: Lift-Off
- Post-Its (Optional)
- Task Card Student Version: Culminating Project
- Project Organizer

Per Group

- Poster paper and markers

Whole Class

- Poster paper and markers
- *See Instructions in Lift-Off for other optional materials to use for the class concept map

Task 1 (5 days, based on 45-minute periods)

Per Student

- Task Card Student Version: Task 1
- Project Organizer
- Optional: Red and blue colored pencils

Per Group

- Resource Cards #1-4
- Computer
- Optional: Red and blue colored pencils

Whole Class

- Projector and Speakers

Task 2 (3.5 days, based on 45-minute periods)

Per Student

- Task Card Student Version: Task 2
- Project Organizer

Per Group

- 4 ziploc bags with labels on them
- 20 cotton balls
- Bowl of water
- 12-16 lima beans (soak dry lima beans overnight before giving to students)
- 2 pieces of masking tape

6th Grade Science Unit 3: Nature via Nurture

Teacher Materials List

- Pen/Pencil
- For whole class: sunny window or sun lamp, dark space like a cupboard or closed box Whole Class

Task 3 (4 days, based on 45-minute periods)

Per Student

- Task Card Student Version: Task 3
- Project Organizer

Per Station

- 1-2 of each Research Station Card

Whole Class

- Projector and Speakers (for video)

Task 4 (4 days, based on 45-minute periods)

Per Student

- Task Card Student Version: Task 4
- Project Organizer
- “Gene Card” – Make a randomized gene card for each student that details the alleles for all their monster’s genes (Example: HH Tt ee)
- Asexual Reproduction Bag
 - Brown paper bag
 - 2 pipe cleaners of one color – one short, one long
- Optional: Colored Pencils

Per Pair

- Sexual Reproduction Bag
 - Brown paper bag
 - 4 pipe cleaners of one color – two short, two long
 - 4 pipe cleaners of a different color – two short, two long

Whole Class

- Optional: Projector to show picture and review new vocabulary

Culminating Project (8 days, based on 45-minute periods)

News Update

- Recording Device (phone, computer, camera, etc.)
- Movie Editing Software (Optional)
- Poster Paper (Optional for visuals)
- Color pencils/markers or computer graphics (Optional for Visuals)
- Computers: Publishing Software with Newspaper Template or Google Drawings

Letter to the Mayor

- Lined Paper or Computer with Word Processing
- Pens/Pencils

6th Grade Science Unit 3: Nature via Nurture

Building on Prior Knowledge

In Unit 2, students focused heavily on Earth Science as they built a knowledge base around weather and climate. In this unit, students continue to explore weather, considering its causes and how it affects the growth of organisms as an environmental factor, in addition to the genetic factors also at play. In this culminating project, students are asked to give a news update on a local lake plagued by algal blooms, explaining what environmental and genetic factors might be at play.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans five different Disciplinary Core Ideas in this unit: ESS2.C: The Roles of Water in Earth’s Surface Processes, ESS2.D: Weather and Climate, LS1.B: Growth and Development of Organisms, LS3.A: Inheritance of Traits, and LS3.B: Variation of Traits.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Developing and Using Models, Planning and Carrying Out Investigations, and Constructing Explanations. In addition to science and engineering practices, students also continue to build on their knowledge of the crosscutting concept of Cause and Effect.

*This summary is based on information found in the NGSS Framework.

K-8 Progression of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for Unit 3

Disciplinary Core Ideas	K-2	3-5	6-8
ESS2.C The Roles of Water in Earth’s Surface Processes	Water is found in many types of places and in different forms on Earth.	Most of Earth’s water is in the ocean and much of the Earth’s freshwater is in glaciers or underground.	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of seawater drive interconnected ocean currents.
ESS2.D Weather and Climate	Weather is the combination of sunlight, snow or rain, and temperature in a particular region and time. People record weather patterns over time.	Climate describes patterns of typical weather conditions over different scales and variations. Historical weather patterns can be analyzed.	Complex interactions determine local weather patterns and influence climate, including the role of the ocean.
LS1.B Growth and Development of Organisms	Parents and offspring often engage in behaviors that help the offspring survive.	Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles.	Animals engage in behaviors that increase the odds of reproduction. An organism’s growth is affected by both genetic and environmental factors.
LS3.A Inheritance of Traits	Young organisms are very much, but not exactly, like their parents and also resemble other organisms of the same kind.	Different organisms vary in how they look and function because they have different inherited information; the environment also affects the traits that an organism develops.	Genes chiefly regulate a specific protein, which affects an individual’s traits.

6th Grade Science Unit 3: Nature via Nurture
Building on Prior Knowledge

<p>LS3.B Variation of Traits</p>			<p>In sexual reproduction, each parent contributes half of the genes acquired by the offspring, resulting in variation between parent and offspring. Genetic information can be altered because of mutations, which may result in beneficial, negative, or no change to proteins or traits of an organism.</p>
---	--	--	--

<p>Science and Engineering Practices</p>	<p>K-2</p>	<p>3-5</p>	<p>6-8</p>
<p>Developing and Using Models*</p>	<p>Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.</p> <ul style="list-style-type: none"> • Develop and/or use a model to represent amounts, relationships, relative scales (bigger/smaller), and/or patterns in the natural and designed world(s). 	<p>Modeling in 3-5 builds on prior experiences and progresses to building and revising simple models and using models to represent events and design solutions.</p> <ul style="list-style-type: none"> • Develop and/or use models to describe and/or predict phenomena. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. 	<p>Modeling in 6-8 builds on prior experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.</p> <ul style="list-style-type: none"> • Develop and use a model to describe phenomena.
<p>Planning and Carrying Out Investigations*</p>	<p>Planning and carrying out investigations in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</p> <ul style="list-style-type: none"> • Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. 	<p>Planning and carrying out investigations in 3-5 builds on prior experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. 	<p>Planning and carrying out investigations in 6-8 builds on prior experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

6th Grade Science Unit 3: Nature via Nurture
Building on Prior Knowledge

<p>Constructing Explanations*</p>	<p>Constructing Explanations in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena.</p> <ul style="list-style-type: none"> Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena. 	<p>Constructing Explanations in 3-5 builds on prior experiences and progresses to the use of evidence and ideas in constructing explanations that specify variables that describe and predict phenomena.</p> <ul style="list-style-type: none"> Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem. 	<p>Constructing Explanations in 6-8 builds on prior experiences and progresses to include constructing explanations supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> 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.
--	--	--	---

*These SEPs are summatively assessed using the Culminating Project or a Task-Specific Rubric.

Crosscutting Concepts	K-2	3-5	6-8
<p>Cause and Effect*</p>	<p>Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes.</p> <ul style="list-style-type: none"> Events have causes that generate observable patterns. 	<p>Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.</p> <ul style="list-style-type: none"> Cause and effect relationships are routinely identified, tested, and used to explain change. Events that occur together with regularity might or might not be a cause and effect relationship. 	<p>Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

*These CCCs are summatively assessed using the Culminating Project or a Task-Specific Rubric.

6th Grade Science Unit 3: Nature via Nurture

Building on Prior Knowledge

Progression of Knowledge from Kindergarten – 8th grade

ESS2.C. The Role of Water in Earth’s Surface Processes: In Kindergarten through second grade, students begin to gather information about where water can be found on Earth, whether it be in solid or liquid form. In fifth grade, students analyze more specific data about the reservoirs that they identified in K-2 and make the distinction between freshwater and saltwater. By graphing the amount of water in oceans, lakes, rivers, glaciers, groundwater, and polar ice caps, they are able to realize that nearly all of Earth’s water is in the ocean and most freshwater is in glaciers or underground, not rivers and lakes. While these Performance Expectations lay the foundation by showing students where water is located on Earth, the middle school Performance Expectations take a great leap in this DCI. In Unit 2, students examined how water cycles throughout Earth systems, what causes water to cycle, and how the movement of water results in climate conditions and ocean currents. In this unit, students focus less on climate and more on how the movement of water in the atmosphere is a major determinant of local weather patterns. In seventh and eighth grade, students continue to explore this DCI as they examine how water causes weathering and erosion that change land’s features. Because of the vast number of Performance Expectations, students engage in a wide variety of Science and Engineering Practices and Crosscutting Concepts.

The following is the progression of the Performance Expectations for this DCI:

- 2-ESS2-3** Obtain information to identify where water is found on Earth and that it can be solid or liquid.
- 5-ESS2-2** Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
- MS-ESS2-2** Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.
- MS-ESS2-4** Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.
- MS-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- MS-ESS2-6** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

ESS2.D. Weather and Climate: Students do not engage with this DCI until the third grade. In third grade, students begin to distinguish between weather and climate by using data to describe weather patterns for one PE and gathering information to describe climate conditions for another PE. Because of the nature of this content, students are focusing on the CCC of Patterns at this level. This sets the stage for them to explore the actual mechanisms behind weather and climate at the middle school level. In Unit 2, students used models to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine climates. In this unit, students build on this knowledge to move away from climate and consider how interactions of air masses result in specific weather conditions. Because the middle school PEs deal more with the causes of weather and climate, students emphasize the CCCs of Systems and System Models and Cause and Effect at this grade band.

6th Grade Science Unit 3: Nature via Nurture

Building on Prior Knowledge

The following is the progression of the Performance Expectations for this DCI:

- 3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions for a particular season.
- 3-ESS2-2** Obtain and combine information to describe climates in different regions of the world.
- MS-ESS2-5** Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- MS-ESS2-6** Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

LS1.B. Growth and Development of Organisms: In first grade, students begin to engage with this DCI by thinking about plant and animal behaviors that help the offspring to survive. In third through fifth grade, students take a step back from survival behaviors and look at the big picture of organisms—that while diverse, they all have a life cycle that involves reproduction. In the middle school grade band, students combine these concepts of survival behaviors and life cycles. In this unit, students focus on the growth aspect of the life cycle as they gather evidence for how environmental and genetic factors influence the growth of plants. In the next unit, students will build on their prior knowledge from first grade as they learn that certain animal behaviors and plant structures can increase the odds of reproduction—which is another key aspect of life cycles that they explored in third grade. Students first focus on the crosscutting concept of Patterns, but later switch to the lens of Cause and Effect. There is also a wide variety of Science and Engineering Practices across the PEs, as shown below.

The following is the progression of the Performance Expectations for this DCI:

- 1-LS1-2** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
- 3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
- MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect probability of successful reproduction of animals and plants respectively.
- MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

LS3.A. Inheritance of Traits: In Kindergarten through second grade, students make observations based on examples they can see in order to conclude that plants and animals look like their parents. This physical observation-based understanding sets the foundation for them to engage with the science behind this phenomenon in third – fifth grade. At this level, students continue to look for Patterns in data, but start using content-specific vocabulary and concepts, such as traits, inheritance, and variation. Furthermore, they continue on to consider that it is not just genetics that can influence traits, but also environment. In this middle school unit, students dive into the actual mechanisms at play when

6th Grade Science Unit 3: Nature via Nurture

Building on Prior Knowledge

they think about inheritance of traits. By making models of the processes of asexual and sexual reproduction, they are able to see why some organisms have identical offspring and why others have offspring with genetic variation. Through these concepts, students are also introduced to new scientific terms related to inheritance, such as chromosome, gene, allele, and offspring. This sets the stage for a later eighth grade unit as students build on this knowledge to consider how genes actually result in traits. In this later unit, students will see that variation results not just from inheritance but also mutations. In earlier grades, students focus on Analyzing and Interpreting Patterns in Data to Construct Explanations. In the middle school units, students build on these skills to Develop Models that describe the underlying mechanisms, utilizing the crosscutting concepts of Cause and Effect or Structure and Function.

The following is the progression of the Performance Expectations for this DCI:

- 1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
- 3-LS3-1** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
- 3-LS3-2** Use evidence to support the explanation that traits can be influenced by the environment.
- 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.
- MS-LS3-2** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

LS3.B. Variation of Traits: As you can see by the identical performance expectations listed below, this DCI is heavily linked to LS3.A Inheritance. Recall that in Kindergarten through second grade, students are making observations based on examples they can see in order to conclude that plants and animals look like their parents. This also includes a conclusion that plants and animals do not look exactly like their parents, thus laying the foundation for this concept of variation. In third – fifth grade, they continue to explore this idea of variation in more depth, analyzing data sets for evidence of variation that result from both genetics and environment. In this sixth grade unit, students discover that variation occurs because of the processes in sexual reproduction. In the later eighth grade unit, they will focus on variation that occurs because of mutation. Due to the nature of the performance expectations at the different levels, students start by Analyzing and Interpreting Patterns in Data in order to Construct Explanations, but move toward Developing Models using Cause and Effect or Structure and Function in the middle school units.

The following is the progression of the Performance Expectations for this DCI:

- 1-LS3-1** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.
- 3-LS3-1** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

6th Grade Science Unit 3: Nature via Nurture
Building on Prior Knowledge

-
- 3-LS3-2** Use evidence to support the explanation that traits can be influenced by the environment
- 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.
- MS-LS3-2** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

**6th Grade Science Unit 3: Nature via Nurture
Culminating Project**



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

In the Lift-Off Task, students saw the consequences of a lake experiencing a toxic algae bloom. For their culminating project, students imagine a local lake is experiencing the same kind of toxic algae bloom this summer. Fish are dying, the lake is closed to swimming, and there are no dogs allowed on the trails around the lake because consuming the algae could cause serious illness. This isn't the first time this has happened to this lake, and the community wants to know—what is going on?!

Their task is to figure out exactly why this is happening and what can be done—is it an environmental issue or has the algae itself actually changed? As a group, students create a news story update on the local lake situation, share any new evidence they have uncovered, and explain what this means. This can either be a video newscast or an article in the local newspaper. Individually, they then write a letter to the town's mayor explaining the problem and advocating for a potential solution given what they know.

3-Dimensional Assessment

ESS2.C: The Roles of Water in Earth's Surface Processes

- The complex patterns of the changes and the movement of water in the atmosphere determined by winds, landforms, ocean temperatures and currents, are major determinants of local weather patterns.

ESS2.C: Weather and Climate

- Because these patterns are so complex, weather can only be predicted probabilistically.

LS1.B: Growth and Development of Organisms

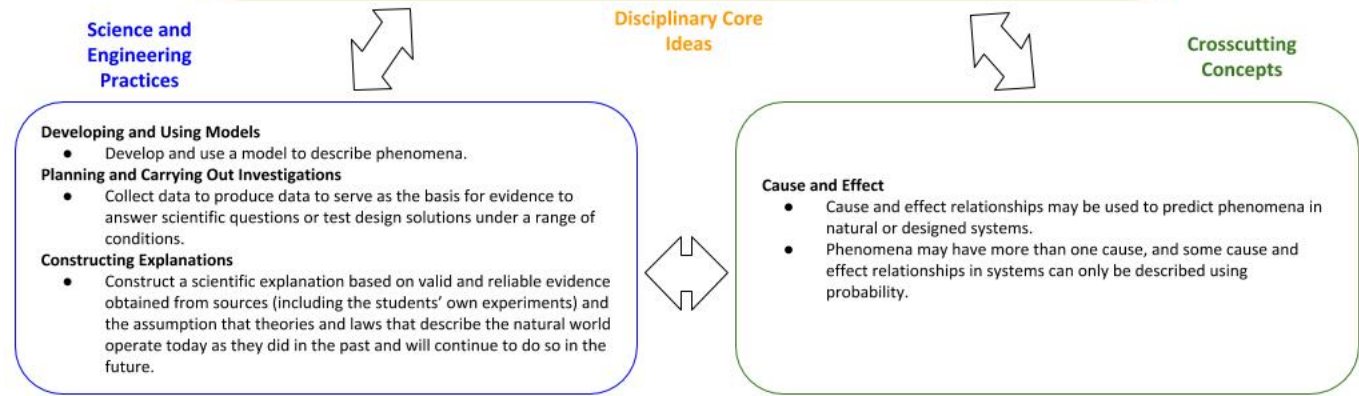
- Genetic factors as well as local conditions affect the growth of the adult plant.
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring (*secondary*).

LS3.A: Inheritance of Traits

- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

LS3.B: Variation of Traits

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.



6th Grade Science Unit 3: Nature via Nurture

Culminating Project

Time Needed (Based on 45-Minute Periods)

8 days at end of unit

- Group Project: 3 periods (includes 1 presentation day)
- Individual Project: 5 periods
 - First draft: 3 periods
 - Feedback: 1 period
 - Revision: 1 period

Materials

News Update

- Recording Device (phone, computer, camera, etc.)
- Movie Editing Software (Optional)
- Poster Paper (Optional for visuals)
- Color pencils/markers or computer graphics (Optional for Visuals)
- Computers: Publishing Software with Newspaper Template or Google Drawings

Letter to the Mayor

- Lined Paper or Computer with Word Processing
- Pens/Pencils

Instructions for the Culminating Project

1. Introduce the Culminating Project at the end of the Lift-Off task, including both group and individual components outlined in the Challenge.
2. Read over the Culminating Project Task Card with the students. We recommend only reading the Challenge and Group Project Criteria for Success at this time in order to not overwhelm students with information.
 - We have provided background information on a mock local lake, but you may choose to gather the same type of data for a lake in your community that also has algal blooms.
 - Review the background information with students. At this point, you may choose for students to discuss the data and make some preliminary hypotheses about what this background information might tell them about the lake problem. They will return to this background information repeatedly throughout the unit.
 - Take questions for clarification.
3. Remind students as they complete the Project Organizer that they will be planning pieces of their news update and recording scientific concepts they will likely need for their individual project. However, there is nothing wrong with going back and changing their ideas over the course of the unit. The students won't fully develop their news update or letter to the mayor until the end of the unit, so change during the imaginative and creative time is acceptable and often experienced.
4. Make sure the students fill out the Project Organizer after each task, which will help the students think about different parts of their news update video or article along the way. This process allows students to both apply and document relevant scientific concepts as they move throughout the unit. This will inform both their group and individual projects.

**6th Grade Science Unit 3: Nature via Nurture
Culminating Project**

- We recommend that students complete the Project Organizer individually. They might discuss ideas first as a group, but should then respond individually. This allows students time to process concepts on their own and generate their own ideas, which can be used later when it comes to developing their group project.

5. The table below summarizes how the Project Organizer guides the students through developing different components of their video or article news update (group product) and letter to the mayor (individual product).

Task	Project Organizer	Group and Individual Culminating Project
<p>Lift Off The Mystery of the Algal Bloom</p>	<ul style="list-style-type: none"> • Why are algal blooms a problem? • What do you think might be causing the algal bloom in the local lake? 	<ul style="list-style-type: none"> • Group: A recap of the problem at the local lake • Individual: A description of the problem at the local lake
<p>Task 1 Forecasting the Weather</p>	<p>Review the background information on the local lake.</p> <ul style="list-style-type: none"> • How has the weather changed from year to year? • Based on what you learned about air masses and weather fronts, what causes these different kinds of weather? • What role might weather play in algal blooms, based on the data? 	<ul style="list-style-type: none"> • Group: An explanation of why algal blooms happen some years but not others • Individual: An explanation of what likely caused different weather conditions from year to year, supported by evidence
<p>Task 2 What Affects Plant Growth?</p>	<ul style="list-style-type: none"> • What natural environmental factors do you think affect the growth of the toxic algae? <ul style="list-style-type: none"> ○ How does the data from the Culminating Project handout support this? • Do some research on what other environmental factors might also be affecting the growth of the toxic algae. What else might be causing algal blooms besides weather conditions? 	<ul style="list-style-type: none"> • Group: An explanation of the environmental factors that cause the lake’s algal blooms • Individual: An explanation of all the specific factors that cause the toxic algal blooms, including evidence. A description of how finding out the causes of toxic algal blooms helped them come up with a solution
<p>Task 3 Genetics or Environment?</p>	<p>Researchers have also identified the gene that leads to the toxic protein, but it is not found in all types of algae, just toxic ones like Blue-Green algae.</p> <ul style="list-style-type: none"> • Based on the information you have, do you think the toxic algal bloom in the local lake is caused by genetics or environmental factors? Explain your reasoning. 	<ul style="list-style-type: none"> • Group: An explanation for whether the lake’s algal blooms are caused by genetic and/or environmental factors • Individual: An explanation for whether the lake’s algal blooms are caused by genetic and/or environmental factors, including evidence
<p>Task 4 From Parent to Offspring</p>	<ul style="list-style-type: none"> • Refer back to your model: How do cyanobacteria (blue-green algae) reproduce? • Does this better support the case for algal blooms being caused by genetics or environmental factors? Explain. 	<ul style="list-style-type: none"> • Group: N/A • Individual: A model that shows how Cyanobacteria reproduces and what this means for genetic variation

6th Grade Science Unit 3: Nature via Nurture

Culminating Project

6. After all the learning tasks and the Project Organizer are completed, the students can start to develop their news update in the format of their choice (article or video). The Project Organizers and Group Project Criteria for Success should be used as reference to remind students to include all the components of their news update.
 - As always, we recommend the use of group roles for Culminating Project work time (See “How to Use This Curriculum” for details). We recommend changing the roles every work day.
7. Once student groups have presented their news updates, students are ready to move on to their individual project. Each student will write a letter to the mayor that explains the problem and advocates for a solution given what they know. This can be a handwritten letter or digital letter but it must meet all the criteria in the student handout. A template is provided at the end of this document, but make sure that students understand they should also be referencing the *Individual Project Criteria for Success* as they write their letters.
8. Conduct a peer review of the letters after students have completed a first draft.
 - Copy the Letter Peer Review Feedback form found in the Student Instructions. Another option is to use the Student 3-Dimensional Individual Project Rubric.
 - Assign each student a partner, preferably a partner from a different group.
 - Students switch drafts and assess them using the peer review feedback form.
 - Remind each student to give one positive comment and one constructive comment for each section on the checklist.
 - Allow students time to present their feedback to their partner, so their partner may ask clarifying questions if needed.
9. After receiving feedback, allow students time to complete a final draft based on the feedback they received.

Assessment

The Project Organizer can be formatively assessed using:

- *Criteria of your choice*. We recommend using the 3-Dimensional Assessment matrix from the Unit Overview to inform your criteria.

The Group Culminating Project will be summatively assessed using:

- The *Group Project Criteria for Success* Checklist

The Individual Culminating Project will be summatively assessed using:

- The *3-Dimensional Individual Project Rubric*.
- Keep in mind that the Proficient level indicates that the student has successfully demonstrated understanding of the criteria. Because we are in the early stages of NGSS adoption, it may take multiple opportunities throughout the course of the year for students to reach Proficient.
- If you wish to give students a numeric score, you could take the average score of all of their rubrics or add up rubric scores to give students a summation out of the total. Because of the note above, this scoring may not correlate to traditional grading systems.
- While we recommend scoring all of the project criteria with the rubrics for each student, we understand the burden of that level of scoring.

**6th Grade Science Unit 3: Nature via Nurture
Culminating Project**

- One option is to select the rubrics that you wish to focus on for this project and use those to assess each student's individual project.
- Another option is to review the Proficient level of each of the project's rubrics and use the descriptions to generally analyze all student work for trends.

6th Grade Science Unit 3: Nature via Nurture
Culminating Project

Letter to the Mayor Template

Dear Ms. Mayor,

The condition of the local lake is a serious problem! *In this paragraph, describe the problem at the local lake.*

Here is what we know about the toxic algae, which is also known as Blue-Green Algae, or Cyanobacteria. *In this paragraph, describe what you know about the Blue-Green Toxic Algae.*

We also know that these algal blooms have happened before. This is the history of algal blooms in the last five years as well as how weather conditions have varied over these five years. *In this paragraph, use the weather data in the last five years to explain what might have caused these changes.*

I believe that these toxic algal blooms are caused by _____ (environmental or genetic) factors. *In this paragraph, make a claim for whether the toxic algal blooms are caused by environmental or genetic factors, identify the specific factors, and support your claim with evidence.*

Based on this information, I propose that we... *In this paragraph, explain your potential solution for the lake, including a description of how finding out all this information helped inform your solution.*

Thank you for your time and consideration.

Sincerely,

**6th Grade Science Unit 3: Nature via Nurture
3-Dimensional Individual Project Rubric**

Overview: The following rubrics can be used to assess the individual project: a letter to the mayor about the algal bloom problem. Each rubric is aligned to one section of the *Individual Project Criteria for Success*, located on the Culminating Project Student Instructions. *If student provides no assessable evidence (e.g., “I don’t know” or leaves answer blank), then that student response cannot be evaluated using the rubric and should be scored as a zero.

Below we provide an alignment table that details the dimensions assessed for each criterion.

	Student Criteria for Success	Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
1	<ul style="list-style-type: none"> ✓ Background on the Blue-Green Toxic Algae (<i>Cyanobacteria</i>), including: <ul style="list-style-type: none"> ○ A model that shows how they reproduce and what this means for variation in their species ○ A description of their optimal growing conditions 	Developing and Using Models <ul style="list-style-type: none"> ● Develop and use a model to describe phenomena. 	LS1.B: Growth and Development of Organisms <ul style="list-style-type: none"> ● Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring (<i>secondary</i>). ● Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. 	Cause and Effect <ul style="list-style-type: none"> ● Cause and effect relationships may be used to predict phenomena in natural or designed systems.
2	<ul style="list-style-type: none"> ✓ Background on the relevant history of weather in the region, including: <ul style="list-style-type: none"> ○ An explanation of what likely caused these different weather conditions from year to year, supported by data from Task 1 as evidence 	Planning and Carrying Out Investigations <ul style="list-style-type: none"> ● Collect data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. 	ESS2.C: The Roles of Water in Earth’s Surface Processes <ul style="list-style-type: none"> ● The complex patterns of the changes and the movement of water in the atmosphere determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. ESS2.D: Weather and Climate <ul style="list-style-type: none"> ● Because these patterns are so complex, weather can only be predicted probabilistically. 	Cause and Effect <ul style="list-style-type: none"> ● Cause and effect relationships may be used to predict phenomena in natural or designed systems.
3	<ul style="list-style-type: none"> ✓ An explanation for whether the toxic algal blooms are caused by genetic and/or environmental factors, including: <ul style="list-style-type: none"> ○ All the specific factors that cause the toxic algal blooms ○ Evidence from the tasks that 	Constructing Explanations <ul style="list-style-type: none"> ● Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students’ own 	LS1.B: Growth and Development of Organisms <ul style="list-style-type: none"> ● Genetic factors as well as local conditions affect the growth of the adult plant. 	Cause and Effect <ul style="list-style-type: none"> ● Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using

**6th Grade Science Unit 3: Nature via Nurture
3-Dimensional Individual Project Rubric**



	<p>supports the explanation for how environmental and genetic factors affect growth of organisms</p>	<p>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.</p>		<p>probability.</p>
--	--	---	--	---------------------

**6th Grade Science Unit 3: Nature via Nurture
3-Dimensional Individual Project Rubric**

Rubric 1: Student develops a model to describe how *Cyanobacteria* reproduce, which also describes the effect on genetic variation in offspring.

- Dimensions Assessed: SEP – Developing and Using Models, DCI – LS1.B: Growth and Development in Organisms and LS3.A: Inheritance of Traits, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student develops an inaccurate model to describe how <i>Cyanobacteria</i> reproduce.	Student develops a partial model to describe how <i>Cyanobacteria</i> reproduce.	Student develops a complete model to describe how <i>Cyanobacteria</i> reproduce, which also implicitly describes the effect on genetic variation in offspring.	Student develops a complete model to describe how <i>Cyanobacteria</i> reproduce, which also explicitly describes the effect on genetic variation in offspring.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student draws an inaccurate model for reproduction in <i>Cyanobacteria</i>. For example, the model shows <i>Cyanobacteria</i> reproducing sexually, shows two parents, or shows reproduction leading to genetic variation. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows <i>Cyanobacteria</i> reproducing asexually. Model includes one parent and one offspring that look identical, but does not include labels of traits and alleles. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows <i>Cyanobacteria</i> reproducing asexually. Model includes one parent and one offspring, including labels of sample traits and alleles for each. • Student accurately shows that parent and offspring have identical genes and traits. While student shows exactly where each of the offspring’s alleles came from (using arrows or color-coding), they do not explicitly describe how this process results in offspring with no genetic variation. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows <i>Cyanobacteria</i> reproducing asexually. Model includes one parent and one offspring, including labels of sample traits and alleles for each. • Student accurately shows and explicitly explains that parent and offspring have identical genes and traits, showing exactly where each of the offspring’s alleles came from (using arrows or color-coding). • See sample model in <i>Elaborate</i> section of the Task 4 Teacher Version.

Notes:

- An additional rubric is provided in the Task 4 Teacher Version to assess sexual reproduction, since the organism in this Culminating Project does not reproduce sexually.
- Student’s description of optimal growing conditions for *Cyanobacteria* is not assessed, but is included in the criteria so students set the context for their explanation of the effects of environment.

**6th Grade Science Unit 3: Nature via Nurture
3-Dimensional Individual Project Rubric**

Rubric 2: Student explains how the motions and interactions of air masses likely caused the changing weather conditions, describing Task 1 data* as evidence.

- Dimensions Assessed: SEP – Planning and Carrying Out Investigations, DCI – ESS2.C: The Roles of Water in Earth’s Surface Processes and ESS2.D: Weather and Climate, CCC – Cause and Effect
- *Examples of data are weather maps, diagrams, and visualizations (found in Task 1).

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<p>Student inaccurately explains how the motions and interactions of air masses likely caused the changing weather conditions, describing Task 1 data* as evidence with major errors.</p>	<p>Student generally explains how the motions and interactions of air masses likely caused the changing weather conditions, describing Task 1 data* as evidence with major omissions.</p>	<p>Student accurately explains how the motions and interactions of air masses likely caused the changing weather conditions, describing Task 1 data* as evidence with minor omissions or errors.</p>	<p>Student accurately explains how the motions and interactions of air masses likely caused the changing weather conditions, describing Task 1 data* as evidence in complete detail.</p>
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes how years with algal blooms have typically had more rainfall and/or higher summer temperatures. • Student attempts to explain the reasoning behind the weather conditions but does so with such large errors, the response is considered inaccurate. For example, student explains that the storms that result in increased rainfall are caused by two air masses swirling and mixing together. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes how years with algal blooms have typically had more rainfall and/or higher summer temperatures. Student may only explain one of the above changing weather conditions, which constitutes a major omission. • Student’s explanation of the changing weather condition(s) is general. For example, student explains that the increase in rainfall was likely a result of storms, which are caused by weather fronts. While this is generally true, it does not go into the detailed mechanisms of air mass interactions. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes how years with algal blooms have typically had more rainfall and higher summer temperatures. • Student’s explanations of these changing weather conditions is mostly accurate, but with a few missing details or a minor error. See the <i>Advanced Look-Fors</i> and the sample explanations in the <i>Explain</i> section of the Task 1 Teacher Version. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student describes how years with algal blooms have typically had more rainfall and higher summer temperatures. • Student accurately explains the cause of increased rainfall by using Task 1 resources to describe the interaction of air masses in weather fronts (for example, cold fronts). See sample explanation in <i>Explain</i> section of the Task 1 Teacher Version. • Student accurately explains the higher summer temperatures by using Task 1 resources to describe a dense, dry air mass that becomes compressed during a heat wave. See sample explanation in <i>Explain</i> section of the Task 1 Teacher Version.

**6th Grade Science Unit 3: Nature via Nurture
3-Dimensional Individual Project Rubric**

Rubric 3: Student explains whether the toxic algal blooms are caused by environmental and/or genetic factors, using evidence from the tasks.

- Dimensions Assessed: SEP – Constructing Explanations, DCI – LS1.B: Growth and Development of Organisms, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<p>Student inaccurately explains whether the toxic algal blooms are caused by environmental and/or genetic factors.</p>	<p>Student accurately explains whether the toxic algal blooms are caused by environmental and/or genetic factors, using no evidence from the tasks.</p>	<p>Student accurately explains whether the toxic algal blooms are caused by environmental and/or genetic factors, using at least one piece of evidence from the tasks.</p>	<p>Student accurately explains whether the toxic algal blooms are caused by environmental and/or genetic factors, using multiple pieces of evidence from the tasks.</p>
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student inaccurately explains that the toxic algal blooms are only caused by environmental OR genetic factors. • For example: Student might say it is only genetics because this specific type of “algae” has the gene to produce the toxin; OR Student might cite only environmental factors, such as, temperature increases, rainfall increases, and increased fertilizer runoff. • Evidence from the tasks may or may not be provided. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student accurately explains that the toxic algal blooms are caused by both environmental and genetic factors. • Student supports genetics by describing how this specific type of “algae” has the gene to produce the toxin. Student supports environment by describing factors such as, temperature increases, rainfall increases, and increased fertilizer runoff. • No evidence from the tasks is provided. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student accurately explains that the toxic algal blooms are caused by both environmental and genetic factors. • Student supports genetics by describing how this specific type of “algae” has the gene to produce the toxin. Student supports environment by describing factors such as, temperature increases, rainfall increases, and increased fertilizer runoff. • To support the idea that growth is caused by both environmental and genetic factors, student describes evidence from at least one of the five resource cards in Task 3 or their experiment in Task 2. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student accurately explains that the toxic algal blooms are caused by both environmental and genetic factors. • Student supports genetics by describing how this specific type of “algae” has the gene to produce the toxin. Student supports environment by describing factors such as, temperature increases, rainfall increases, and increased fertilizer runoff. • To support the idea that growth is caused by both environmental and genetic factors, student describes evidence from at least two of the five resource cards in Task 3 or their experiment in Task 2.

**6th Grade Science Unit 3: Nature via Nurture
Project Organizer**



Unit Essential Question: *How do people use technology to survive in regions with different climates?*

You have been asked to give a news story update on a local lake that is also suffering from a recurring toxic algal bloom. After each task, you will return to the table below to organize what you learn as you go through the unit. By the end of the four tasks, you will have all this information to use for your culminating project. For each activity, be sure to include answers to **ALL** the questions provided.

<p>Lift-Off Task: The Mystery of the Algal Bloom</p>	<p>Based on what you learned from the Lake Temescal news story and the background information about the local lake you are focusing on, answer the following questions:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Why are algal blooms a problem? <input type="checkbox"/> What do you think might be causing the algal bloom in the local lake?
<p>Task 1: Forecasting the Weather</p>	<p>In your Culminating Project document, you were given background information on the region where the lake is located. Review this information and answer the following questions:</p> <ul style="list-style-type: none"> <input type="checkbox"/> How has the weather changed from year to year? <input type="checkbox"/> Based on what you learned about air masses and weather fronts, what causes these different kinds of weather? <input type="checkbox"/> What role might weather play in algal blooms, based on the data?

**6th Grade Science Unit 3: Nature via Nurture
Project Organizer**



<p>Task 2: What Affects Plant Growth?</p>	<p>We have seen how environmental factors can play a role in the growth of organisms.</p> <ul style="list-style-type: none"> <input type="checkbox"/> What natural environmental factors do you think affect the growth of the toxic algae? <ul style="list-style-type: none"> ○ How does the data from the Culminating Project handout support this? <input type="checkbox"/> Do some research on what other environmental factors might also be affecting the growth of the toxic algae. What else might be causing algal blooms besides weather conditions?
<p>Task 3: Genetics or Environment?</p>	<p>In Task 2, we identified some environmental factors that cause toxic algae growth. Researchers have also identified the gene that leads to the toxic protein, but it is not found in all types of algae, just toxic ones like Blue-Green algae.</p> <ul style="list-style-type: none"> <input type="checkbox"/> Based on the information you have, do you think the toxic algal bloom in the local lake is caused by genetics or environmental factors? Explain your reasoning.

**6th Grade Science Unit 3: Nature via Nurture
Project Organizer**

<p>Task 4: From Parent to Offspring</p>	<p>An algal bloom refers to a large growth of algae, so we need to know how they actually reproduce!</p> <ul style="list-style-type: none"><input type="checkbox"/> Refer back to your model: How do cyanobacteria (blue-green algae) reproduce?<input type="checkbox"/> Does this better support the case for algal blooms being caused by genetics or environmental factors? Explain.
---	--

6th Grade Science Unit 3: Nature via Nurture

Lift-Off Task: Extreme Conditions



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

Lakes around the country are experiencing toxic algal blooms that are making them dangerous to both humans and other organisms. In this Lift-Off Task, students are introduced to one example, Lake Temescal in Oakland, which has been repeatedly closed due to recurring toxic algal blooms. After watching a news story about this phenomenon, students begin to generate questions that might help them better make sense of what is happening in lakes like these. These questions will guide students throughout the unit as they continue to make sense of algal blooms, their causes and consequences, and what can be done about them.

Alignment Table

<p>Crosscutting Concept (*depending upon student-generated questions)</p> <ul style="list-style-type: none"> ● Cause and Effect <ul style="list-style-type: none"> ○ Cause and effect relationships may be used to predict phenomena in natural or designed systems. ○ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.
<p>Equity and Groupwork</p> <ul style="list-style-type: none"> ● Share and listen to broad and diverse student contributions. ● Make connections between each other’s ideas. ● Work together to co-construct a concept map.
<p>Language</p> <ul style="list-style-type: none"> ● Use connector words to link ideas. ● Generate and write questions about the phenomenon. ● Organize key questions in a concept map.

Learning Goals

This learning task introduces students to the phenomenon of the Lake Temescal algal bloom so they can begin generating questions that will guide them through the unit. More specifically, the purpose is to:

- Individually generate a list of questions about the Lake Temescal algal bloom, using observations from the news video.
- Make connections between related questions.
- Generate possible answers to questions, using prior knowledge.
- Use information from the news story and project background information to describe why algal blooms are a problem and hypothesize what might be causing them in the local lake for their culminating project.

Content Background for Teachers

This task introduces students to a toxic algal bloom in Lake Temescal in Oakland, California. These types of toxic algal blooms are becoming more and more common across the country. The algal blooms that are toxic are caused by blue-green algae that aren’t technically algae at all; they are a photosynthetic bacteria called Cyanobacteria that release a toxin. This toxin affects the nervous system if consumed, causing severe illness in humans and possibly even death in dogs and other wildlife.

6th Grade Science Unit 3: Nature via Nurture**Lift-Off Task: Extreme Conditions**

While these are the immediate effects humans see, there are also greater consequences with algal blooms. As more algae and plants grow, others die, creating a lot of dead organic matter to be decomposed by bacteria. This causes bacteria to increase in number and use up all the oxygen in the water. Thus many fish and other aquatic organisms cannot survive, killing off all of these organisms.

Algal blooms, such as the one in Lake Temescal, are becoming more common either directly or indirectly because of human impact. Blue-Green Algae, or Cyanobacteria, have an optimal growth temperature that is 20° F higher than regular algae. Thus, increasing temperatures due to climate change are one major cause of these toxic algal blooms. However, the largest cause of these algal blooms is an excess of nutrients (particularly phosphorus and nitrogen) in the water. This is mostly due to runoff of synthetic fertilizers from sources such as lawns and farms. High rainfall also facilitates this runoff into rivers, streams, and ponds, so algal blooms are also seen in years with more rainfall. Because the algae are photosynthetic, more sunlight also increases algal blooms, as well as slow-moving water. All of these are environmental factors that contribute to algal blooms, which students will be considering for their culminating project.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions, and is a successful academic language instruction tool. In this task, students will likely add only predictions about cause-and-effect relationships. As students learn more about algal blooms and environmental conditions, they will add more complex questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.

Academic Vocabulary

- Toxic
- Algal Bloom
- Blue-Green Algae
- Cyanobacteria
- Fahrenheit

*Additional academic vocabulary will vary by class

Time Needed (Based on 45-Minute Periods)

2 Days

- Introduction, Part A and Part B: 1 period
- Class Concept Map, Project Overview, and Project Organizer: 1 period

Materials

- Unit 3, Lift-Off Task Student Version

Part B

- Poster paper and markers
- Post-Its (Optional)

Part C

- Class Poster Paper and markers

6th Grade Science Unit 3: Nature via Nurture**Lift-Off Task: Extreme Conditions**

- *See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

- Culminating Project Handout
- Project Organizer Handout

Instructions

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.
2. Lakes around the country are experiencing toxic algal blooms that are making them dangerous to both humans and other organisms. In this activity, students are introduced to one example—Lake Temescal in Oakland, CA.
3. First, show the following news video to introduce students to the phenomenon of the Lake Temescal Algal Bloom: <https://abc7news.com/health/toxic-algae-bloom-in-oaklands-lake-temescal-prompts-closure/2156561/>
 - Make sure to pause at 1:30 because the video then starts to get into causes and solutions, which we want students to find out on their own throughout the unit.

Part A

1. In this section of the task, students will generate questions to help them make sense of the phenomenon—the toxic algal bloom in Lake Temescal. Using these self-generated questions throughout the unit will help them get a better understanding of algal blooms, including their consequences and causes.
2. Have students complete this section individually in their student guide.
 - For students who need more support, encourage them to think back to the video, and consider any questions they had as they were watching. You may also want to show the video a second time.
 - Here is a list of some potential questions students might generate: “What is an algal bloom? What are algae? Why is an algal bloom a problem? Why can algae sometimes be toxic and not other times? How are other organisms affected besides humans and dogs? What are some other environmental effects? What is causing the algal bloom? Why does it keep happening? Are there many causes? What can we do about this?”

Part B:

1. In this part of the task, students create a concept map as a group.
 - Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member’s list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
 - Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.

6th Grade Science Unit 3: Nature via Nurture

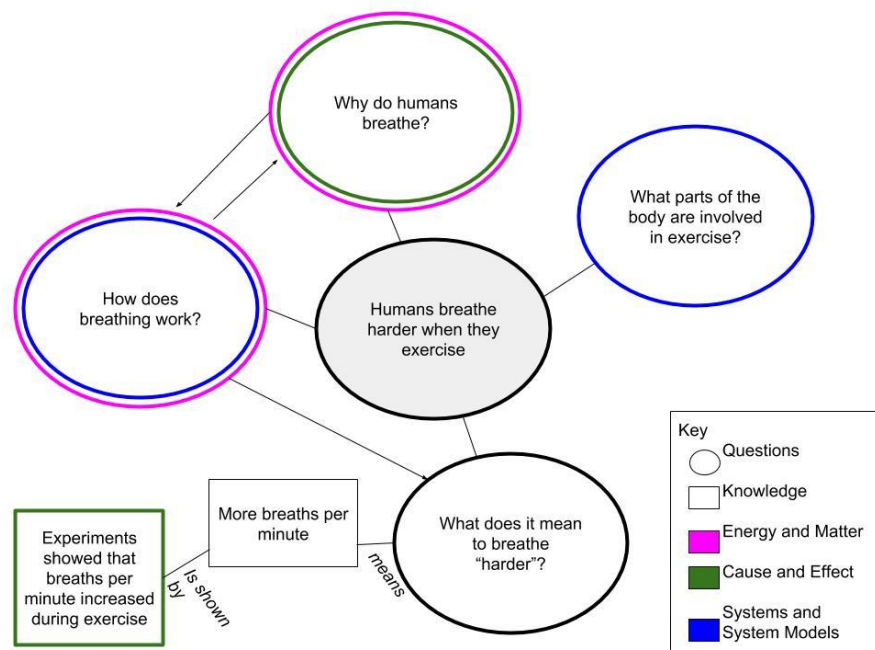
Lift-Off Task: Extreme Conditions

- Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See “How to Use this Curriculum” for more details).

2. Students will post their posters on a wall and then walk around and look at each group’s ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

How to Concept Map

For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.



1. Write the phenomenon in the middle of the poster, in this case “Humans breathe harder when they exercise.”
2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board.
3. Model the process of reviewing the list and finding similarities amongst the questions.
 - Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge.
4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles.
5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student’s prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.

6th Grade Science Unit 3: Nature via Nurture**Lift-Off Task: Extreme Conditions**

- Use connector words to identify the relationships between the content boxes (See image above for an example).
6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. *Note: not all boxes and circles will necessarily have a crosscutting concept.

Part C

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of the toxic algal bloom in Lake Temescal.
 - Start with the phenomenon in the middle.
 - Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you'll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
 - Ask students to identify any connections they see between the questions and record these as lines between the questions.
 - Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
 - The purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content but will also help their oral and written language development.
 - This whole class concept map will be revisited at the end of each task, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?
2. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.
 - If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
 - Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
 - We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

6th Grade Science Unit 3: Nature via Nurture**Lift-Off Task: Extreme Conditions**

3. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).
 - The crosscutting concept for this unit is Cause and Effect, but there are two different elements emphasized. You may choose to assign one color for the entire crosscutting concept that can be used throughout the unit, or choose two colors to represent the two different elements of Cause and Effect.
 - Have students analyze the class concept map for as many examples of the crosscutting concept or crosscutting concept element as they can find. This will entirely depend on the questions they have.
 - We recommend modeling this process by picking a question, identifying the crosscutting concept or crosscutting concept element, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
 - **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.

Connecting to the Culminating Project

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
 - We have provided background information on a mock local lake, but you may choose to gather the same type of data for a lake in your community that also has algal blooms.
 - Review the background information with students. At this point, you may choose for students to discuss the data and make some preliminary hypotheses about what this background information might tell them about the lake problem. They will return to this background information repeatedly throughout the unit.
 - Take questions for clarification.
2. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
 - Students have been asked to give a news story update on a local lake that is suffering from a recurring toxic algal bloom. The student prompt is as follows: Based on what you learned from the Lake Temescal news story and the background information about the local lake you are focusing on, answer the following questions:
 - ✓ Why are algal blooms a problem?
 - ✓ What do you think might be causing the algal bloom in the local lake?

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
 - At the beginning of this task, you made a list of all the questions you have about algal blooms. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?

6th Grade Science Unit 3: Nature via Nurture**Lift-Off Task: Extreme Conditions**

- In this unit, we will be focusing on one crosscutting concept: **Cause and Effect**: Cause and effect relationships can be used to predict phenomena, and phenomena may have more than one cause. Looking at your class concept map, give one example of how this crosscutting concept came up in today's task.
 - Now that you understand what project you'll be working on over the course of this unit, what else do you need to know? What additional questions do you have?
2. There are no right answers but encourage students to look back at their initial lists and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and the gathering of knowledge and skills for their final project.

6th Grade Science Unit 3: Nature via Nurture

Task 1: Forecasting the Weather



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

In the Lift-Off task, students learned about the Lake Temescal toxic algal bloom in Oakland, CA—just one of many toxic algal blooms in lakes and ponds across the country. In this task, students begin to consider what causes these algal blooms and why they only happen in some years but not others. In order to explore these questions, students need to dig into weather. Building on what they have already learned about climate, students collect data to provide evidence for how the movement and interactions of air masses result in different weather conditions. This data comes in the form of diagrams, simulations, videos, and weather maps. Using this information, students are able to return to the phenomenon of Lake Temescal and explain some possible causes for the weather experienced in Oakland, CA during a year that Lake Temescal suffered a toxic algal bloom. This will help them for their culminating project, as they analyze how the weather in that region might be causing algal blooms in the local lake.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.</p> <p><i>[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through</i></p>	<p>Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. 	<p>ESS2.C: The Roles of Water in Earth’s Surface Processes</p> <ul style="list-style-type: none"> The complex patterns of the changes and the movement of water in the atmosphere determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. <p>ESS2.D: Weather and Climate</p> <ul style="list-style-type: none"> Because these patterns are so complex, weather can only be predicted probabilistically. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

6th Grade Science Unit 3: Nature via Nurture

Task 1: Forecasting the Weather



<p>laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]</p>			
<p>Supplementary Science and Engineering Practices</p> <ul style="list-style-type: none"> • Developing and Using Models <ul style="list-style-type: none"> ○ Develop and use a model to describe phenomena. 			
<p>Equity and Groupwork</p> <ul style="list-style-type: none"> • Participate in group roles to collect data on air masses and weather. • Use the <i>Stronger Clearer</i> method to give and receive feedback. 			
<p>Language</p> <ul style="list-style-type: none"> • Read text and pull out new terms, definitions, and idea. • Represent ideas in written and visual formats. • Use the <i>Stronger Clearer</i> method to improve language. 			

Learning Goals

This learning task asks students to explore how the motions and interactions of air masses cause changing weather conditions. More specifically, the purpose is to:

- Engage prior knowledge of weather conditions.
- Explore the movement and interactions of air masses using multiple resources.
- Explain two types of weather in a region in terms of air masses.
- Use the *Stronger Clearer* method to improve an explanation or diagram.
- Apply knowledge of air masses and weather to explain project-specific weather data and make claims about causes of algal blooms.

Content Background for Teachers

In this task, students explore how the motions and interactions of air masses cause changing weather conditions. These are very complex processes that build on concepts from Units 1 and 2, such as unequal heating of earth, atmospheric and oceanic circulation, particle motion, density and pressure, etc. We encourage you to explicitly refer back to these related concepts and return to past activities if necessary.

You can find all background information related to this task in the *Explore* Station Cards, including the videos and simulations referenced. This website is also a great resource that summarizes many of the concepts explored in this task: http://iflyamerica.org/safety_air_masses_and_fronts.asp.

6th Grade Science Unit 3: Nature via Nurture**Task 1: Forecasting the Weather****Academic Vocabulary**

- Weather Condition
- Forecast
- Air Mass
- Continental
- Marine
- Arctic
- Polar
- Tropical
- Weather Front (warm, cold, occluded, stationary)
- Pressure
- Dense

Time Needed (Based on 45-Minute Periods)

5 Days

- Engage: 0.5 period
- Explore: 2 periods
- Explain: 0.5 period
- Elaborate: 1 period
- Evaluate and Reflection: 1 period

*You may want to have students set up their Task 2 experiment before starting Task 1. This option makes it possible for students to collect data while completing Task 1 and have data ready to work with in Task 2.

Materials

- Unit 3, Task 1 Student Version

Engage

- Projector and Speakers

Explore (Per group)

- Resource Cards #1-4
- Computer
- Optional: Red and blue colored pencils

Explain

- Optional: Red and blue colored pencils

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 1: In the Lift-Off task, you learned that algal blooms are causing big problems in many lakes and ponds, like Lake Temescal. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?

6th Grade Science Unit 3: Nature via Nurture**Task 1: Forecasting the Weather**

- Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 1: But what causes algal blooms? Why do algal blooms only happen some years but not others? In this task, we will be investigating one possible cause of algal blooms.
 - Now pass out their Task 1 student guide.
 3. Encourage students to think back to Unit 2 and what they learned about climate. Review the distinction between climate and weather in their Student Guide and emphasize that in this task, they will be focusing on weather.
 4. To spark any prior knowledge of weather conditions, show the following weather forecast:
<https://abc7news.com/weather/accuweather-forecast-atmospheric-river-arrives-today/39468/>.
 - While any weather forecast would accomplish this purpose, we chose one specific to the area where Lake Temescal is located, since students will be coming back to this phenomenon throughout the task and throughout the unit.
 5. Students then discuss the questions in their Student Guides in pairs, which ask students to brainstorm different types of weather conditions (ie. temperature, precipitation, wind, cloud cover, humidity, etc).
 - For the second question, you may choose to have students actually go outside to make observations or merely look out the window.
 - Share some of these ideas out and make a class list of these weather conditions. We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

Explore

1. Students already know what weather conditions are, but the question now becomes what causes these conditions. In this task, students explore this question through the context of Lake Temescal’s algal bloom.
 - Review the introduction in the Student Guide with students, which tells them that the region experienced a lot of storms during winter and an unusually warm summer during the year of the toxic algal bloom.
2. Students collect data to provide evidence for how the movement and interactions of air masses might cause these kinds of weather conditions. In accordance with the clarification statement for this PE, this data comes in the form of diagrams, simulations, videos, and weather maps.
 - Through this process, students are using the SEP of **Planning and Carrying Out Investigations** as they collect data to serve as evidence for the causes of Oakland’s stormy weather and hot weather. Through this activity, students are also emphasizing the CCC of **Cause and Effect** as they discover general cause-and-effect relationships between air masses and weather conditions, which they can later use to explain Oakland’s specific weather conditions.
 - As students draw diagrams of weather phenomena, they are also beginning to use the SEP of **Developing and Using Models**.

6th Grade Science Unit 3: Nature via Nurture**Task 1: Forecasting the Weather**

3. Distribute the resource cards and computers to each group and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to manipulate the materials needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
 - Ask the Recorder to make sure the group is recording their analysis in their Student Guide.
4. In Resource Cards 3 and 4, we ask students to discuss a few questions to help them process the information. Below is some additional content background that may help you support students with these questions.
 - Resource Card 3: Cold fronts tend to lead to the most intense weather and precipitation, whereas warm fronts tend to be more moderate.
 - Resource Card 4: A high-pressure system, shown by a capital H, is a dense air mass that is usually cooler and drier than the surrounding air. These areas usually experience fair weather. If air above this air mass gets pulled toward the ground, this compresses the mass even more and causes heat waves. A low-pressure system, shown by a capital L, is a less dense air mass that is usually wetter and warmer than the surrounding air. These areas experience clouds and storms. Keep in mind that air usually flows from areas of high pressure to areas of low pressure.
5. Once all groups engage with all the resources in their groups, we recommend conducting a class debrief that helps to link all the pieces of information together. Explaining weather is very challenging for students, so reviewing this information as a class will be very helpful before they have to individually explain these ideas.
 - One option is to co-construct class diagrams and flowcharts on the board, asking groups facilitating questions to help them add information. You may organize this however makes sense to you, but in general the schematic drawings should show: 1) air masses taking on the characteristics of the region below them, 2) why air masses move (ie. pressure) and how this creates winds, 3) weather fronts, and 4) weather associated with pressure systems.
 - We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See "How To Use This Curriculum" for more details).

Explain

1. Now that students have collected the data to explain all connections between air masses and weather, they can tackle the question for the original phenomenon: What are some possible causes for Oakland's storms in winter and high temperatures in summer?
 - This activity again emphasizes the CCC of **Cause and Effect**, as students use the cause-and-effect relationships they just explored to predict what might be happening in the specific phenomenon of Oakland's weather.
 - Students can choose to answer this with words or a model, thus again emphasizing the supplementary SEP of **Developing and Using Models**.
 - We recommend students do this task individually since they will be sharing their explanations/models with partners in the *Elaborate* activity.

6th Grade Science Unit 3: Nature via Nurture

Task 1: Forecasting the Weather

2. Possible Student Sample:

Stormy Weather	Hot Weather
<p>Oakland is in California, so the air mass involved is likely the maritime polar air mass. The cold, high-pressure maritime polar mass sinks toward the equator and meets the warmer, low-pressure mass above Oakland. This causes a cold front, where the cold air mass pushes under the warm air mass, causing it to rise, cool, and condense, causing rainy storms that can last several days. There may also be other kinds of weather fronts that produce these storms during winter.</p>	<p>The unusually hot weather in the summer is caused by the continental tropical air mass moving into the Oakland area. When the air above this air mass gets pulled toward the ground, it compresses the air mass even more and causes a heat wave and even drier conditions. This is further exacerbated by the more direct sun rays during summertime.</p>

Elaborate

1. Students will now participate in a language routine known as *Stronger Clearer*. This activity gives students the opportunity to share their ideas, gather feedback, and revise their explanations and models. This protocol is especially useful for extremely complex content with a lot of new scientific terminology, such as weather mechanisms.
2. Students will share with three different partners, allowing them to discuss feedback and record any notes each time. Once complete, students should be given time to individually revise their explanations/diagrams based on their discussions. A protocol is provided in their student guide.
3. The revised explanations/diagrams are a good option for formative assessment. Collect student work to identify trends in students’ ability to accurately describe the cause-and-effect relationship between air mass motion/interactions and weather conditions. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Return to the whole-class concept map from the Lift-Off Task.
 - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
 - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how weather conditions affect algal blooms, causes of weather conditions.

6th Grade Science Unit 3: Nature via Nurture**Task 1: Forecasting the Weather**

- Use this opportunity to really check for understanding of the new content presented through the resource cards.
- Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
 - **Cause and Effect:** These could be phrases such as, "that results in," "that causes," "that explains why," "is due to," etc.
- Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 1 section of the Unit 3 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.
2. You have been asked to give a news story update on a local lake that is suffering from a recurring toxic algal bloom. Their prompt is as follows: In your Culminating Project document, you were given background information on the region where the lake is located. Review this information and answer the following questions:
 - ✓ How has the weather changed from year to year?
 - ✓ Based on what you learned about air masses and weather fronts, what causes these different kinds of weather?
 - ✓ What role might weather play in algal blooms, based on the data?

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
 - At the beginning of this task, you were asked to brainstorm different types of weather conditions. Based on what you learned today, could you add any additional weather conditions? List them below.
 - In this task, we focused on the crosscutting concept of **Cause and Effect**: Cause and effect relationships can be used to predict phenomena, and phenomena may have more than one cause. Where did you see examples of **Cause and Effect** in this task?
 - Now that you have learned more about the causes of weather that may play a role in algal blooms, what questions do you still have?
2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their

6th Grade Science Unit 3: Nature via Nurture**Task 1: Forecasting the Weather**

own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

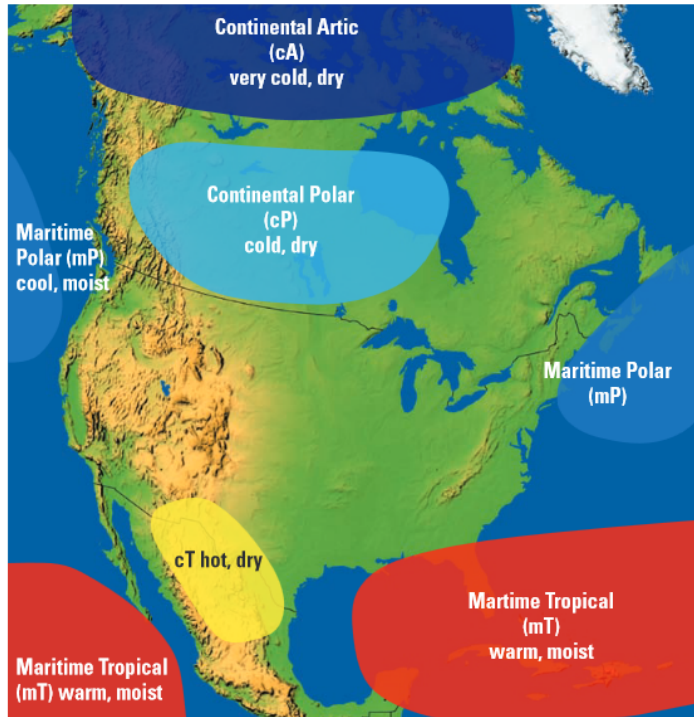
1. You may collect students' Project Organizer and assess using:
 - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
 - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
 - Students may make changes to their Project Organizer according to your comments OR
 - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Resource Cards: What Causes Weather?

Explore

**Resource 1:
What is An Air Mass?**

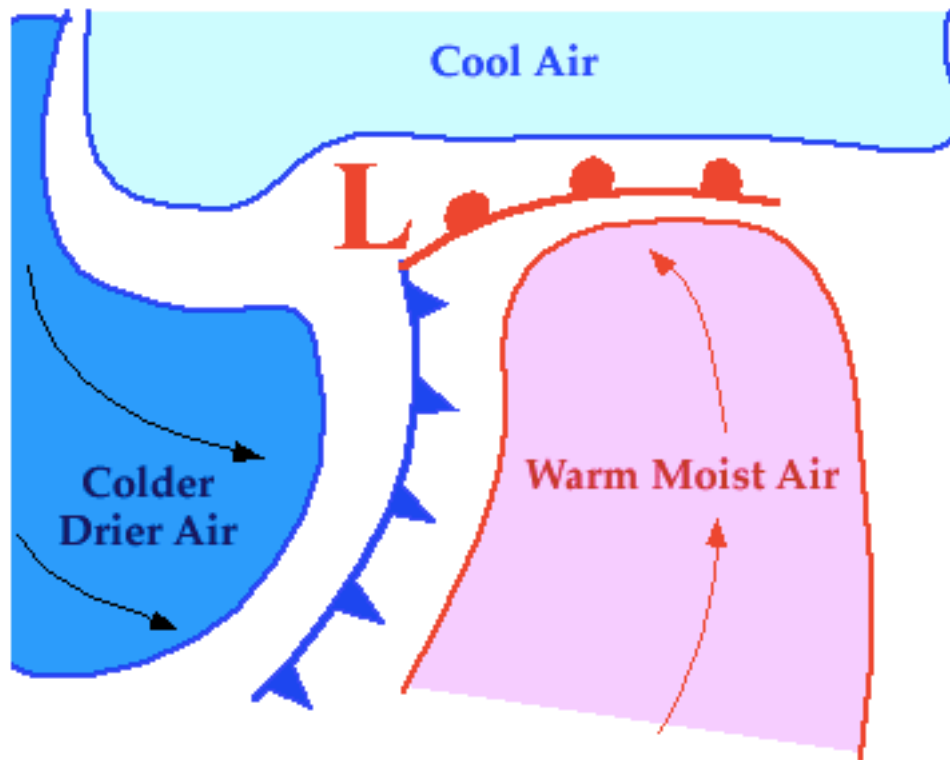


Air masses are large bodies of air that are mostly uniform in temperature and moisture. They take on the characteristics of the region below them.

Key:
 c = continental (above land, dry)
 m = marine (above oceans, moist)
 A = Arctic (from arctic region, very cold)
 P = Polar (from polar region, cold)
 T = Tropical (from near equator, warm)

Remember in Unit 2...	Related Information For This Task
Evaporation over land and ocean causes different amounts of water in the atmosphere.	When the air mass is above land, it makes a dry air mass; this is called a <u>continental</u> air mass. When the air mass is above the ocean, it makes a moist air mass; this is called a <u>marine</u> air mass.
The Sun heats Earth unequally because the Earth is a sphere!	Air masses can therefore have different temperatures depending on their location. The terms <u>arctic</u> , <u>polar</u> , and <u>tropical</u> describe where the air mass comes from. For example, take a look at the diagram above: The air mass that develops over Mexico is called a continental tropical air mass. The air mass is warm because it formed over a region near the Equator that gets more direct sunlight, and it is dry because it forms over land (not water).
Because of Earth's tilt and orbit, regions experience different seasons throughout the year.	Because of Earth's tilt, the air masses shift in latitude throughout the year. For example, the continental tropical air mass sits over Mexico in the Spring, but shifts above northern California during the Summer.

Resource 2:
How Do Air Masses Move?



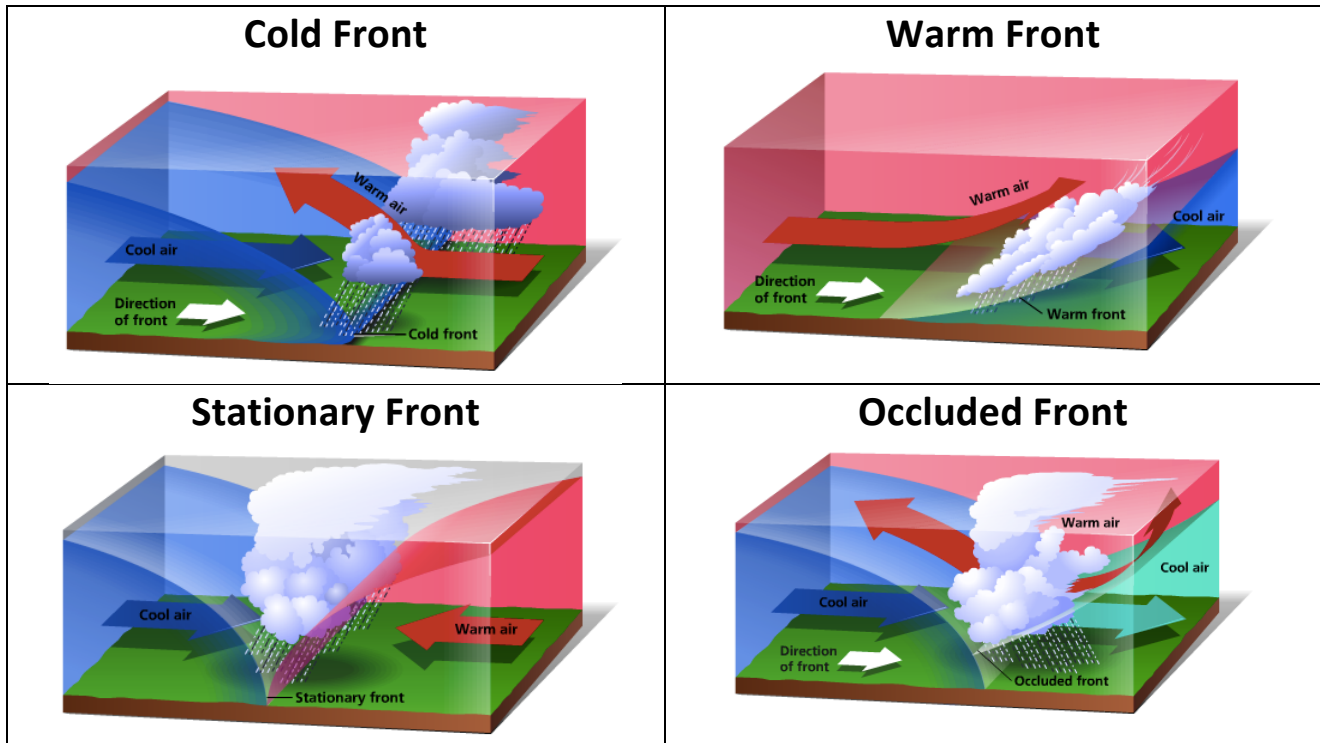
Remember from Unit 2 that the Sun heats different regions of the Earth unevenly. Because the areas around the equator get the most direct sunlight, these air masses are the warmest!

You might also remember from experiments in Unit 2 that warm substances are less dense and rise, whereas cold substances are denser and sink.

- High Pressure: When cold, dense air moves down towards the ground, it exerts a force down onto the air beneath it, creating higher pressure. Sinking air usually pushes clouds away and removes moisture from the air, thus decreasing the chance of rain.
- Low Pressure: Low-pressure areas (shown as an "L" above) have warm, less dense air that rises and sends moisture up into the air. This creates clouds and precipitation as the water vapor condenses.

This means that tropical air masses (warm, low-pressure) rise towards the poles, while polar air masses (cold, high-pressure) sink toward the equator. As the Earth rotates, this creates winds! When winds move air masses, they carry their weather conditions from the source region to a new region. If it clashes with another air mass with different temperature and moisture, this causes a weather front, which you will explore in Resource 3.

Resource 3: Weather Fronts

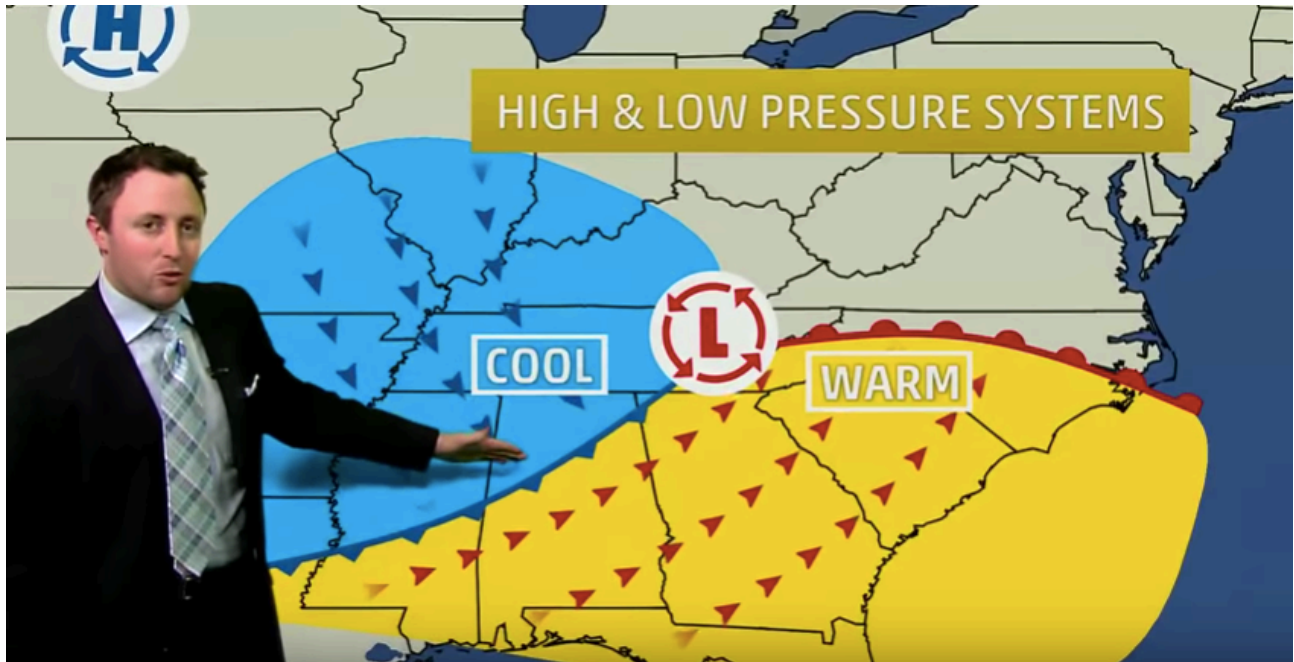


Weather fronts occur when two air masses of different temperature and moisture collide. Go to: http://www.phschool.com/atschool/phsciexp/active_art/weather_fronts/ to explore the 4 types of weather fronts.

Based on what you saw in the simulations:

- What types of fronts lead to the most intense weather and precipitation?
- What types of fronts tend to lead to more moderate weather events?

Resource 4:
Weather Maps



Watch the following video to better understand weather maps:
<https://www.youtube.com/watch?v=9NZz-EeveJ8> (Stop at 2:45).

Practice: Based on what you learned in the video,

- What pressure system would you expect during fair weather?
- What pressure system would you expect during stormy weather?

6th Grade Science Unit 3: Nature via Nurture

Task 2: What Affects Plant Growth?



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

In the last task, students investigated weather, examining how the motion and interaction of air masses creates varying weather conditions. In this task, students think about how changing weather means changing the environment for all kinds of organisms who live in that region. For example, if there is more rainfall and more sunny days in a year, will plants grow more? Students use this context to consider the question of how environmental factors influence the growth of organisms. By identifying the cause-and-effect relationship between environmental change and growth of plants, they will be able to predict that algal blooms are also likely caused by environmental changes—increased temperature, increased rainfall, and excess fertilizer runoff—the latter of which is found through additional research. While this task only explicitly focuses on the environmental aspect of the PE, MS-LS1-5, it sets the stage for students to also explore the impact of genetic factors in the next task.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> 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. 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Genetic factors as well as local conditions affect the growth of the adult plant. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. <p>*While students begin to think about cause and effect relationships in this task, they don’t truly engage with this CCC until Task 3.</p>

6th Grade Science Unit 3: Nature via Nurture

Task 2: What Affects Plant Growth?



<i>genetic mechanisms, gene regulation, or biochemical processes.]</i>			
Supplementary Science and Engineering Practices <ul style="list-style-type: none"> • Planning and Carrying Out Investigations <ul style="list-style-type: none"> ○ Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. 			
Equity and Groupwork <ul style="list-style-type: none"> • Participate in group roles to set up plant growth experiment. • Discuss ideas and hypotheses with a partner. 			
Language <ul style="list-style-type: none"> • Follow a step-by-step procedure. • Use descriptive language to make observations. • Construct an explanation using a claim, evidence, and reasoning. 			

Learning Goals

This learning task asks students to investigate and explain how environmental factors influence the growth of organisms. More specifically, the purpose is to:

- Engage prior knowledge of environmental conditions that affect plant growth.
- Explore the effect of sunlight and water on plant growth.
- Explain how changing weather conditions can affect plant growth.
- Use prior knowledge to hypothesize why changing the type of plant might affect growth.
- Apply knowledge of the relationship between environmental and growth to research and identify environmental causes of algal blooms.

Content Background for Teachers

For this Performance Expectation, MS-LS1-5, students are asked to construct an explanation for how environmental and genetic factors influence the growth of organisms. This task begins this process by focusing on the first half—that environmental factors influence the growth of plants. There are many environmental factors that influence the growth of plants: sunlight, temperature, space, carbon dioxide, water, fertilizer, etc. In this task, students focus on sunlight and water to provide evidence for this concept. In their investigation, students will find that access to water and sunlight are essential factors for the growth of plants.

However, environment is not the only factor that plays a role. In the *Elaborate* of this task, students are asked to hypothesize why lentils grow differently than lima beans. This begins to get at the idea that genetics also plays a role. We will provide more information on the role of environment *and* genetics in Task 3.

Academic Vocabulary

- Environment
- Environmental Factor
- Growth

6th Grade Science Unit 3: Nature via Nurture**Task 2: What Affects Plant Growth?****Time Needed (Based on 45-Minute Periods)**

3.5 Days

- Engage: 0.5 period
- Explore: 1 period (but data must be collected over a 1-2 week period)
- Explain: 0.5 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

*You may want to have students set up their *Explore* experiment before starting Task 1. This option makes it possible for students to collect data while completing Task 1 and have data ready to work with by the time you start this task.

Materials

- Unit 3, Task 2 Student Version

Explore (Per group)

- 4 ziploc bags with labels on them
- 20 cotton balls
- Bowl of water
- 12-16 lima beans (soak dry lima beans overnight before giving to students)
- 2 pieces of masking tape
- Pen/Pencil
- For whole class: sunny window or sun lamp, dark space like a cupboard or closed box

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 2: In the last task, you investigated causes of varying weather conditions. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
 - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 2: When the weather changes, this changes the environment for all kinds of plants and animals living in a region. How might this kind of change in environment affect plants?
 - Now pass out their Task 2 student guide.
3. Encourage students to use any prior knowledge they have to answer the questions in their Student Guide with their partner.
 - Students have likely been introduced to plant growth in earlier grades, specifically how plants get the material they need for growth chiefly from air and water (5-LS1-1).

6th Grade Science Unit 3: Nature via Nurture**Task 2: What Affects Plant Growth?**

- The background of the picture in their Student Guides can also provide a significant hint.
 - Students will likely come up with factors like water, air, sun, soil, fertilizer, space, etc. Most students should be able to hypothesize that changing these environmental factors will change the growth of the plant accordingly.
4. Share some of these ideas out as a class. We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details)
- This *Engage* asks students to begin to use the CCC of **Cause and Effect** as they use prior knowledge to consider multiple possible causes.

Explore

1. While students listed many factors in the *Engage*, they will just be investigating two of those factors in this *Explore*. In groups, students follow the procedure in their Student Guides to investigate the effect of sunlight and water on the growth of lima beans.
 - This allows students to practice the supplementary SEP of **Planning and Carrying Out Investigations** as they conduct an investigation to gather evidence for how environment influences growth.
 - Students are also continuing their emphasis on the CCC of **Cause and Effect** as they investigate multiple possible causes of variations in plant growth.
2. Distribute all materials and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to gather the materials needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Recorder to make sure the group is recording their data in their Student Guide.
3. Data should be checked every few days for a total of four data collections. We highly recommend having students set up this experiment before Task 1 and having students check the data every few days as you implement Task 1. This will give you sufficient data to begin working with by the time you get to the *Explain* section of this task.
4. Students should record their data in the table in their Student Guides each time they do data collection. This data can be in the form of written observations, actual measurements, and/or diagrams.
 - Once the experiment is complete, you may wish to share out some general lab conclusions before students construct their own explanation in the next section of the task. We encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).

Explain

1. To maintain consistency with the unit storyline, students return to the case of Lake Temescal in Oakland, CA. In the last task, students investigated possible causes for a year of weather that consisted of lots of

6th Grade Science Unit 3: Nature via Nurture

Task 2: What Affects Plant Growth?

rain in winter and lots of sunny days in summer. In this *Explain*, students are asked to use evidence to explain how these environmental factors might affect plant growth.

- This continues to emphasize the CCC of **Cause and Effect**, as students explain how many environmental factors, including sunlight and water, have an effect on plant growth.
- Students are also practicing the SEP of **Constructing Explanations** as they construct an explanation using evidence from their own experiment.

2. Optional Sentence Stems to Use:

- Environmental factors, like _____, do/do not (pick one) affect the growth of plants.
- If the weather in Oakland _____, the plants will likely...
- Our investigation supports this claim because...
- In our lima bean experiment...
- The bag with ___ and ___ ...
- Bag #__, which had ___ and ___,....
- This showed me that...

3. Possible Student Sample:

Claim	Environmental factors, like sunlight and water, affect the growth of plants. Thus, if the weather in Oakland changes to have more rain and more sun, the plants in the area will likely grow more.
Evidence and Reasoning	Our investigation supports this claim. In our lima bean experiment, the beans that had no water and sunlight grew significantly less than the other ones. The bag with water and no sunlight barely grew at all, and the bag with sunlight but no water grew at first but then stopped growing. Bag 1, which had water and sunlight, grew the most. This showed me that changing the environmental conditions, like those that come with weather, will greatly affect the growth of plants.

4. This explanation is a good option for formative assessment. Collect student work to identify trends in students’ ability to construct explanations using experimental evidence. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. In this prompt, students are asked to consider a scenario in which they add a different type of plant to their experiment (lentils), but observe a very different result. This scenario sets the stage for students to begin to think about what else might be at play besides environment—genetics!
 - Again, students are emphasizing the CCC of **Cause and Effect**, as students consider that phenomena, like organism growth, may have more than one cause, and this can extend beyond environmental causes to genetic causes.
2. Students should first discuss this with a partner, but we highly recommend sharing out ideas in a class-wide discussion as this is a great transition for the ideas they will be engaging with in the next task.

6th Grade Science Unit 3: Nature via Nurture**Task 2: What Affects Plant Growth?**

- Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).
3. Return to the whole-class concept map from the Lift-Off Task.
- In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
 - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how environmental factors affect the growth of organisms, specifically plants and toxic algae.
 - Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
 - **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.
 - Once again, the purpose of this concept map is to facilitate the generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 2 section of the Unit 3 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. You have been asked to give a news story update on a local lake that is suffering from a recurring toxic algal bloom. Their prompt is as follows: We have seen how environmental factors can play a role in the growth of organisms.
 - ✓ What natural environmental factors do you think affect the growth of the toxic algae?
 - How does the data from the Culminating Project handout support this?
 - ✓ Do some research on what other environmental factors might also be affecting the growth of the toxic algae. What else might be causing algal blooms besides weather conditions?

6th Grade Science Unit 3: Nature via Nurture**Task 2: What Affects Plant Growth?****Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
 - At the beginning of this task, you were asked to hypothesize how you thought changing environmental conditions might affect the growth of plants. Based on what you learned today, was your hypothesis correct? How could you revise or add to your response?
 - In this task, we focused on the crosscutting concept of **Cause and Effect**: Cause and effect relationships can be used to predict phenomena, and phenomena may have more than one cause. Where did you see examples of **Cause and Effect** in this task?
 - Now that you have learned more about environmental causes of algal blooms, what questions do you still have?
2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
 - *Criteria of your choice*. We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
 - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.
2. You may also give students time to make revisions with one of the two options:
 - Students may make changes to their Project Organizer according to your comments OR
 - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

6th Grade Science Unit 3: Nature via Nurture

Task 3: Genetics or Environment?



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

In the last task, students began to engage with the environmental aspect of the PE, MS-LS1-5. Through investigations, they discovered that environmental factors influence the growth of organisms, like plants. Now they are ready to consider that environment might not be the only factor in play. At the beginning of this task, students are introduced to the “nature vs. nurture” debate, particularly within the context of a pair of identical twins arguing whether they are products of their genetics or environment. After collecting an abundance of scientific evidence on this issue, students are able to return to these twins and explain that it is not an either-or question; in fact, both genetics and environment play a role in their growth. This has caused a shift in the name of this debate to “nature via nurture”, as shown by the title of this unit. In the end of this task, students are given another piece of information that the gene for toxicity in algae has been identified, but is only present in some types of algae. Students are then poised to use all this information, including research from Task 2, to explain whether the toxic algal bloom in the local lake is caused by genetics or environment.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary:</p>	<p>Constructing Explanations</p> <ul style="list-style-type: none"> 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. 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Genetic factors as well as local conditions affect the growth of the adult plant. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

6th Grade Science Unit 3: Nature via Nurture

Task 3: Genetics or Environment?



<i>Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]</i>			
Supplementary Science and Engineering Practices <ul style="list-style-type: none"> • Analyzing and Interpreting Data <ul style="list-style-type: none"> ○ Analyze and interpret data to provide evidence for a phenomenon. 			
Supplementary Crosscutting Concepts <ul style="list-style-type: none"> • Patterns <ul style="list-style-type: none"> ○ Patterns can be used to identify cause and effect relationships. 			
Equity and Groupwork <ul style="list-style-type: none"> • Participate in group roles conduct research in stations. • Use discussion questions to facilitate oral discussion of data analysis with group members. 			
Language <ul style="list-style-type: none"> • Analyze multiple types of data. • Read and summarize evidence from research cards. • Take notes while watching a video. • Synthesize data to construct an explanation. • Construct an explanation using a claim, evidence, and reasoning. 			

Learning Goals

This learning task asks students to gather evidence for how genetic and environmental factors influence the growth of organisms. More specifically, the purpose is to:

- Engage prior knowledge to take an opinion on the nature vs. nurture debate.
- Gather evidence for the effects of genetics and environment in different contexts.
- Explain that genetics and environment influences the twins’ traits, using evidence and reasoning.
- Use new evidence to explain why changing the type of plant affects growth.
- Apply new information about the genes of toxic algae to explain whether a toxic algal bloom is caused by genetics or environment.

Content Background for Teachers

In the last task, students conducted an experiment to show that environmental factors influence the growth of plants. In this task, they gather more evidence to show that both genes and environment influence the growth of organisms. As students construct a more holistic picture through all the evidence, they should find that it is not just environment or just genetics at play; organisms are the way they are because of a combined influence of genetic and environmental factors.

Environmental factors can consist of things like availability of light, space, water, size of habitat, etc. Genetic factors refer to the actual genes of an organism. Because growth is determined by many genetic and environmental causes, specific cause-and-effect relationships can only be described using probability. For example, the fact that not every fish in a large pond grows to the same size is likely due to differences in genetics but could also be due to access to food or another environmental factor.

6th Grade Science Unit 3: Nature via Nurture**Task 3: Genetics or Environment?**

For more information on specific evidence of environmental and genetic factors, please see the Research Station Cards in the *Explore*.

Academic Vocabulary

- Environment
- Genetics
- Nature vs. nurture
- Gene
- DNA
- Trait
- Inherit

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 period
- Explore: 1 period
- Explain: 1 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 3, Task 3 Student Version

Engage

- Projector and Speakers (for video)

Explore (Per station)

- 1-2 of each Research Station Card

Explain

- Projector and Speakers (for video)

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 3: In Task 2, you gathered evidence for some environmental factors that affect the growth of plants. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
 - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

6th Grade Science Unit 3: Nature via Nurture**Task 3: Genetics or Environment?**

2. Transition to Task 3: However, at the end of the task, you also considered two kinds of plants growing in the same environmental conditions, but yielding very different results! Is it just environment or do genetics also play a role in the growth of organisms?
 - Now pass out their Task 3 student guide.
3. As a class, introduce the “nature vs. nurture” argument, including a definition of the two terms, as well as a definition for “genetics”, which students may or may not be familiar with. Have students take an initial stance on the “nature vs. nurture” debate, giving reasoning to support their claim.
4. Then show the following *MosaMack Science* video that presents the phenomenon for their task: two identical twins, Mo and Jasper, that were separated at birth and are now arguing about whether they are products of their genes or environment (<https://www.youtube.com/watch?v=udCtpMZ95r0>). Stop the video at 2:15; they will return to the rest of the video later in the task.
 - Now have students make a hypothesis within this more specific phenomenon.
5. We recommend students make claims individually so they can truly have their own opinion. Then, we also recommend conducting a class vote to share out student opinions and some lines of reasoning. We encourage using a Think-Pair-Share and equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details)
 - This *Engage* asks students to begin to use the CCC of **Cause and Effect** as they begin to consider that multiple causes—environment and genetics—might play a role in the traits of organisms.

Explore

1. To answer this question of nature vs. nurture for Mo and Jasper, students need to collect some evidence. In groups, students visit research stations to gather this evidence.
 - Through the stations, students are continuing their emphasis of the CCC of **Cause and Effect** as they gather evidence of multiple causes for organisms’ traits. As they interpret the data, they make claims of how likely each trait is caused by genetics or environmental factors, using probability percentages. This emphasizes that some cause-and-effect relationships can only be described using probability.
 - Students are also practicing the supplementary SEP of **Analyzing and Interpreting Data** and the CCC of **Patterns** as they analyze and interpret patterns in the various data sets, which provide evidence of these cause and effect relationships.
2. Set up the stations and assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
 - Ask the Facilitator to read the directions and to make sure everyone understands the task.
 - Ask the Materials Manager to handle any materials needed to complete the task.
 - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone’s voice is heard.
 - Ask the Recorder to make sure the group is recording their evidence in their Student Guide.

6th Grade Science Unit 3: Nature via Nurture

Task 3: Genetics or Environment?

3. Keep in mind that some of the graphs and tables in the station cards will be challenging for students to interpret. For example, you may want to use the graph for *Body Fat and Obesity* to model how to read different types of graphs.
4. Sample Evidence Chart
 - The emphasis is not that students have a “correct” percentage for probability, but just that they are thinking about different evidence supports the likelihood of different causes.

Station	Circle whether this station gives evidence for genetics or environment, or both. Predict the probability that this is the cause.	Describe the evidence.
Plant Growth: Strawberry Plants	<i>Environment</i> <i>95-100%</i>	<i>Food waste at 10 t/ha leads to the most plant growth at 15 kg/plant. This shows that environmental factors, like type of fertilizer, affects plant growth.</i>
Plant Growth: Corn	<i>Genetics</i> <i>100%</i>	<i>There are 5 different genes between teosinte and modern-day corn that cause big physical differences between the two. Modern-day corn has kernels that are softer, larger, and a different shape. This is due to genetics.</i>
Human Height	<i>Both</i> <i>60-80% Genetics</i> <i>20-40% Environment</i>	<i>Height is 60-80% caused by genetics and 20-40% caused by environment. Some populations, like Australians, are more likely to inherit genes for height than others, like Chinese populations. Height is also very dependent on environmental factors, mostly nutrition-related.</i>
Twin Studies	<i>Both</i> <i>10-13% Environment (Study 1)</i> <i>12% Genetics (Study 2)</i>	<i>Study 1 shows that environment does have an impact because twins with identical genes were more similar in height and weight when they were raised together than raised apart. Study 2 shows that identical twins (same genes) were more likely to have the same cancer type than non-identical twins (different genes), which means genetics plays a role.</i>
Body Fat and Obesity	<i>Both</i> <i>50% Genetics</i> <i>50% Environment</i>	<i>Scientists have identified 244 genes associated with body weight and fat and also stated that body fat was often inherited from parents. However, other studies also showed that low levels of physical activity increase a person’s risk for obesity, which is an environmental factor.</i>

Explain

1. Now that students have more evidence, they can return to Mo and Jasper’s question of genetics vs. environment.

6th Grade Science Unit 3: Nature via Nurture

Task 3: Genetics or Environment?

2. First show the rest of the video from the *Engage*, which provides more evidence relevant to the scenario and sets them up to construct their explanation.
 - This video also provides some background information on inheritance, as they discuss DNA, genes, and traits, which will not only be helpful for this task, but also for Task 4 when students dig into reproduction.
 - Students should take notes on any new information or evidence they think will help them with their explanation. You may want to give students an opportunity to discuss the new information in pairs or groups as a time to process before they move on to their explanation.
3. In the video, Mo says it was environment that made them who they are, while Jasper says it was because of genes. Students individually construct an explanation to respond to Mo and Jasper, using evidence from their Task 2 investigation, the *Explore* stations, and the video to support their claim.
 - Here students are practicing the SEP of **Constructing Explanations** as they construct an explanation using evidence from a variety of sources. You'll notice that no CER graphic organizer is provided here since students should be fairly comfortable with constructing explanations at this point in the year. However, please provide one if you feel it is necessary.
 - This also continues to emphasize the CCC of **Cause and Effect**, as students explain how both genetic and environmental factors affect traits and any specific cause-and-effect relationships can only be described using probability.
4. Optional Sentence Stems to Use:
 - Jasper and Mo are...
 - Genetics [and/or] environment play a role in their growth because...
 - In our Task 2 experiment, we saw...
 - There is also evidence that genetics plays a role; in the research station about...
 - Most of the research stations all gave evidence that...
 - For example...
 - Another example is...
 - Thus,...
5. Possible Student Sample: *Jasper and Mo are both incorrect. Genetics and environment both play a role in their growth, like all other organisms! In our Task 2 experiment, we saw how environmental factors can affect plant growth when the beans given sun and water grew much taller than the ones without. This is similar to the station about strawberry plants, in which those with large amounts of food waste fertilizer grew the most. There is also evidence that genetics plays a role; in the research station about corn, it said that there are 5 genes that are different in modern-day corn from teosinte, which completely changes the kernels. The rest of the stations all gave evidence that both genetics and environment are involved. For example, one twin study showed that twins raised together were more similar in height and weight, which was evidence for environmental factors. The second twin study showed that identical twins were more likely to have the same cancer type, which was evidence for genetics because they have the same genes. Another example is obesity, which is linked to many genes but is also influenced by physical activity (an environmental factor). Thus, we can't always say for sure which factor is involved for each trait, but we do know genetics and environment influence organisms.*

6th Grade Science Unit 3: Nature via Nurture**Task 3: Genetics or Environment?**

6. This explanation is a good option for formative assessment. Collect student work to identify trends in students' ability to construct an explanation about the genetics vs. environment debate using evidence and reasoning. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. In this prompt, students return to the scenario from Task 2 in which they added a different type of plant to their experiment (lentils), but observed a very different result.
 - Again, students are emphasizing the CCC of **Cause and Effect**, as students encounter another phenomenon that has more than one cause—genetics and environment.
2. Students can complete this explanation in partners, but encourage them to use at least one source of evidence to support their explanation, in alignment with the SEP of **Constructing Explanations**.
 - Possible Student Sample: *We know from the experiment in the last task that environmental factors, like water and sunlight, affect the growth of plants. Since the environmental conditions remained the same in this case, the difference in results is probably because of genetics. Since lentils and lima beans are two different kinds of plants, they have different genes that lead to different amounts of growth.*
3. Share out responses in a class-wide discussion as a check for understanding.
 - Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See "How To Use This Curriculum" for more details).
4. Return to the whole-class concept map from the Lift-Off Task.
 - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
 - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how genetic *and* environmental factors affect the growth of organisms, such as algae.
 - Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:

6th Grade Science Unit 3: Nature via Nurture**Task 3: Genetics or Environment?**

- **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.
- Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 3 section of the Unit 3 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
2. You have been asked to give a news story update on a local lake that is suffering from a recurring toxic algal bloom. Their prompt is as follows: In Task 2, we identified some environmental factors that cause toxic algae growth. Researchers have also identified the gene that leads to the toxic protein, but it is not found in all types of algae, just toxic ones like Blue-Green algae.
 - ✓ Based on the information you have, do you think the toxic algal bloom in the local lake is caused by genetics or environmental factors? Explain your reasoning.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
 - At the beginning of this task, you were asked to make a hypothesis about what made Jasper and Mo the way they are—genetics or environment. Considering what you learned throughout the task, do you think your hypothesis was correct? How would you revise your response based on what you know now?
 - In this task, we focused on the crosscutting concept of **Cause and Effect**: Cause and effect relationships can be used to predict phenomena. Sometimes phenomena may have more than one cause and can only be described using probability. Where did you see examples of **Cause and Effect** in this task?
 - Now that you have learned more about the role of genetics and environment in toxic algal blooms, what questions do you still have?
2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students’ Project Organizer and assess using:
 - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.

6th Grade Science Unit 3: Nature via Nurture**Task 3: Genetics or Environment?**

- This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.
2. You may also give students time to make revisions with one of the two options:
- Students may make changes to their Project Organizer according to your comments OR
 - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Research Station Cards: Genetics vs. Environment

Explore

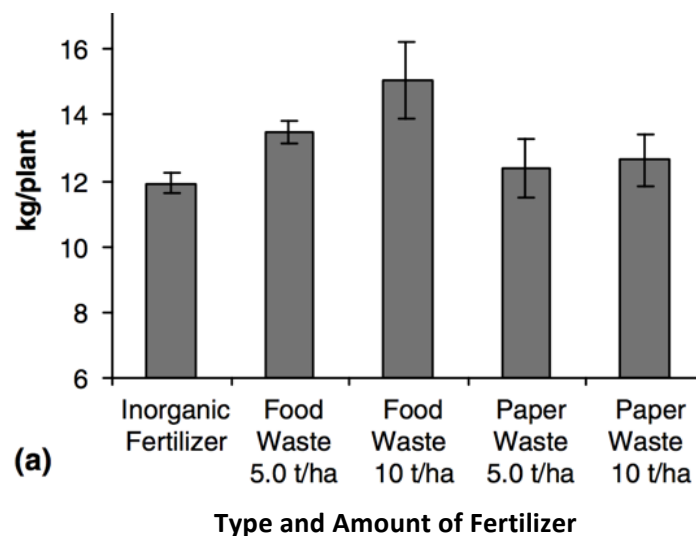
Plant Growth: Strawberry Plants

This study from 2004 looked at how different types and amounts of fertilizers affected the growth of strawberry plants. The growth of the strawberry plants was measured in weight, which is shown in kilograms (kg). The amounts of organic fertilizers were measured in tons/hectare (t/ha). The study measured the effect of three different kinds of fertilizers:



- Inorganic (the kind you can buy at the store)
- Food waste (compost)
- Paper waste (recycled paper)

The study's findings are recorded in the graph below:



Discussion Questions

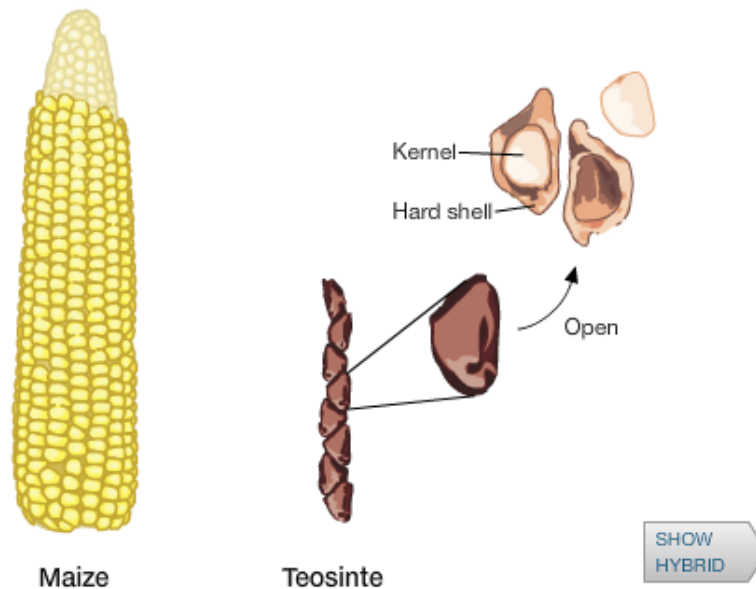
1. Which type and amount of fertilizer led to the most strawberry plant growth?
2. Is fertilizer an environmental factor or genetic factor? Why?

Sources

- <http://www.ncbi.nlm.nih.gov/pubmed/15051076>

Plant Growth: Corn

The corn we eat today evolved from the teosinte plant. Teosinte doesn't look much like the corn (Maize) we eat today, but the genes of these two plants are very similar! There are only about 5 genes responsible for differences you see.



These 5 genes cause big changes! The corn you eat today has more kernels that are softer, larger, and a very different shape than teosinte.

Discussion Questions

1. How is the corn we eat today different than its ancestor, teosinte?
2. Are these differences due to genetics or environment? Why?

Sources

- <http://learn.genetics.utah.edu/content/selection/corn/>

Human Height

Studies show that 60-80 % of human height is caused by genetic factors and 20-40% can be linked to environmental factors, mainly nutrition.



Scientists also found that the likelihood to inherit height can vary from one population to another. For example, the Australian population is more likely to inherit height genes (80%) than the Chinese population (65%) in a study of a Chinese population.

However, height can also change because of environmental factors! Eating foods with protein, calcium, and vitamins A and D in childhood has a large effect on adult height. This means that even if you do have the genetic potential to be very tall, you won't get to that potential if you don't eat the right foods!

Discussion Questions

1. Is height influenced by genetics or environment? Why?
2. If there are environmental factors, what are they?

Sources

- <http://www.scientificamerican.com/article/how-much-of-human-height/>

Twin Studies

Twin studies are one of the best ways scientists can look at the effects of genetics and environment because it is easy to control either the genetics or the environment! Read about two important twin studies below:



Study 1: In one of the first large twin studies, completed in 1990, researchers observed identical twins raised apart and identical twins raised together. This is some of the data they found:

Trait	For Identical Twins Raised Together	For Identical Twins Raised Apart
Height	93% Similar	86% Similar
Weight	83% Similar	73% Similar

Study 2: In January 2016, Lorelai A. Mucci released an article about her study of identical twins and non-identical twins, each pair of twins raised together. In 32% of the total amount of twins, cancer was diagnosed in both twins. The table below shows the percent of identical twins that had the same cancer type and the non-identical twins that had the same cancer type.

	Identical Twins	Non-Identical Twins
Percentage with the Same Cancer Type	38%	26%

Discussion Questions

1. What does Study 1 tell you about the influence of genetics and/or environment?
2. What does Study 2 tell you about the influence of genetics and/or environment?

Sources

- <http://jama.jamanetwork.com/article.aspx?articleid=2480486>
- <http://web.missouri.edu/~segerti/1000H/Bouchard.pdf>

Body Fat and Obesity

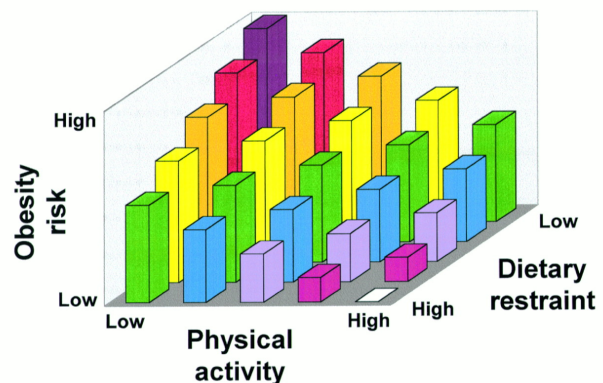
Having a healthy amount of body fat is very important for a person's overall health. Obesity is a condition that occurs when a person's body fat levels enter an unhealthy high range.



In a study done with mice, one group of researchers found that there are 244 genes that caused increased body weight and body fat when they altered them. In humans, scientists have so far identified about 253 genes that are associated with obesity.

Another study found that body fat was often inherited from parents. This was the case 59% of the time for women and 63% of the time for men.

Meanwhile, an article in Science, states that low levels of physical activity and low levels of dietary restraint (high calorie consumption) increase a person's risk for obesity. This is shown in the graph to the right.



Discussion Questions

1. What evidence is there that obesity is caused by genetic factors?
2. What evidence is there that obesity is caused by environmental factors?

Sources

- <http://onlinelibrary.wiley.com/doi/10.1038/oby.2006.71/abstract>
- <http://www.nature.com/ijo/journal/v28/n1/full/0802524a.html>
- <http://science.sciencemag.org/content/280/5368/1371.full>

6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring



Unit Essential Question: *How can we use environmental and genetic factors to explain changes in organisms?*

Introduction

In the last task, students saw evidence that genetics plays a role in the growth of different organisms, but they still don't understand how exactly genetic inheritance works. In this task, they dig into the processes that pass traits from parent to offspring—both sexual reproduction and asexual reproduction. While asexual reproduction is the most important process for their culminating project, students begin by modeling sexual reproduction because it is the more complex of the two processes. In this kinesthetic model, students make “monster babies” to learn that sexual reproduction involves combining half the alleles from each parent to make offspring with genetic variation. To really drive this idea home, students then draw a visual model to show where exactly an offspring’s genes come from. Students then model the much simpler process of asexual reproduction to show why this process does not create genetic variation. In the end, students should be able to explain how cyanobacteria (blue-green algae) inherit their traits and whether this process leads to more or less genetic variation in that species.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.</p> <p><i>[Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]</i></p>	<p>Developing and Using Models</p> <ul style="list-style-type: none"> Develop and use a model to describe phenomena. 	<p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring (<i>secondary</i>). <p>LS3.A: Inheritance of Traits</p> <ul style="list-style-type: none"> Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. <p>LS3.B: Variation of Traits</p> <ul style="list-style-type: none"> In sexually reproducing 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships may be used to predict phenomena in natural or designed systems.

6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring



		<p>organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.</p>	
<p>Equity and Groupwork</p> <ul style="list-style-type: none"> • Discuss ideas with a partner. • Work with a partner to make a monster baby. • Work with a partner to draw a model of asexual reproduction. 			
<p>Language</p> <ul style="list-style-type: none"> • Engage in Pair-Shares to orally practice explaining concepts. • Follow written procedures. • Work with new vocabulary in readings and visuals. • Draw, label, and explain different models. 			

Learning Goals

This learning task asks students to develop models to describe why sexual reproduction results in offspring with genetic variation and asexual reproduction results in offspring with identical genetic information. More specifically, the purpose is to:

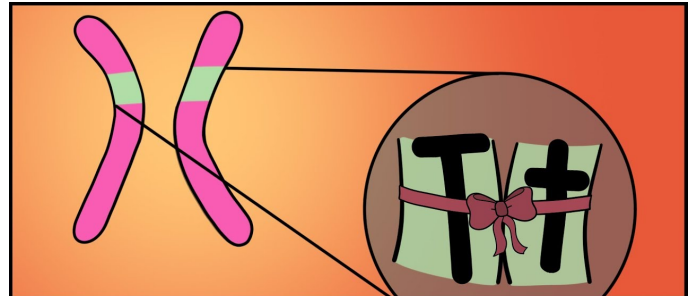
- Engage prior knowledge of inheritance by looking at pictures of two different organisms and their offspring.
- Model sexual reproduction by creating monster babies.
- Draw a model to describe the process of sexual reproduction and explain why it results in genetic variation.
- Model asexual reproduction and describe how it differs from sexual reproduction.
- Apply new knowledge of reproduction processes to describe cyanobacteria (blue-green algae) reproduction and resulting genetic variation.

Content Background for Teachers

In the last task, students were introduced to some concepts around genetics and inheritance. Students learned that genes are specific sections of DNA that code for specific traits, and these genes come from the offspring’s parent. In this task, students build on that knowledge as they think about the process of passing genes from parent to offspring.

6th Grade Science Unit 3: Nature via Nurture**Task 4: From Parents to Offspring**

Let's take the example of humans. Humans reproduce sexually, which involves two parents. Every typical human has 23 pairs of chromosomes, for a total of 46 chromosomes—half of these chromosomes come from one parent, half from the other parent. Because individuals have two of each chromosome, each gene consists of two alleles, one acquired from each parent. These alleles are represented as letters (capital and/or lowercase). In this task, students will model how for each gene, the offspring gets an allele from each parent. These new combinations are what leads to the variation of traits between parents and offspring and amongst siblings.



Asexual reproduction, meanwhile, involves only one parent. In this process, the parent cell grows and divides to form two daughter cells in a process that is similar to mitosis in humans. This generates offspring that are genetically identical to the parent.

Notice that this task includes a lot of new vocabulary. It might be helpful to provide students with definition cards or co-create a class concept map to review all the new vocabulary.

Academic Vocabulary

- Genetic inheritance
- Parent
- Offspring
- Trait
- Variation
- Reproduce
- Gene
- DNA
- Chromosome
- Allele
- Sexual Reproduction
- Asexual Reproduction

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 period
- Explore: 1 period
- Explain: 1 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

6th Grade Science Unit 3: Nature via Nurture**Task 4: From Parents to Offspring****Materials**

- Unit 3, Task 4 Student Version

Explore

- Optional: Projector to show picture and review new vocabulary
- “Gene Card” – Make a randomized gene card for each student that details the alleles for all their monster’s genes (Example: HH Tt ee)
- Reproduction Bag – for each pair of students
 - Brown paper bag
 - 4 pipe cleaners of one color – two short, two long
 - 4 pipe cleaners of a different color – two short, two long

Explain

- Optional: Colored Pencils
- Optional: Projector and Speaker (for video)

Elaborate

- Reproduction Bag – per student
 - Brown paper bag
 - 2 pipe cleaners of one color – one short, one long
- Optional: Colored Pencils

Evaluate

- Project Organizer Handout

Instructions**Engage**

1. Introduce Task 4: In Task 3, you saw the evidence that genetics plays a role in the growth of different organisms. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
 - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.
2. Transition to Task 4: But how does genetic inheritance actually work? How do traits get passed from parent to offspring? Today we will be investigating these processes.
 - Now pass out their Task 4 student guide.
3. Before introducing what students will be doing in the *Engage*, remind students of the term “offspring”, which will be used throughout this task. A definition is provided in their Student Guides.
4. In partners, students will look at two examples of parent organisms and their offspring—dogs and bacteria.
 - In making observations, the hope is that students notice that in dogs, there is trait variation between the parents and offspring, but for bacteria, they look mostly identical. This is because

6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring

dogs reproduce sexually while bacteria reproduce asexually. However, students will not know these terms yet and any observations and hypotheses are valid at this point.

- We recommend sharing out a few responses as a class, using equity sticks to foster more equitable participation (See “How To Use This Curriculum” for more details)

Explore

- Students saw that some organisms, like dogs, can have a variation in traits that is slightly different from their parents. To learn more about the process that makes this possible, students will model sexual reproduction by creating their own monster babies.
 - Here students are using the SEP of **Developing and Using Models** to describe sexual reproduction and variation.
- Before students begin, review some important terminology that will be necessary for the model as a class. Some concepts are a review from Task 3 and some will be new.
 - Optional: Revisit the *Mosamack* video from the last task to review the terms “genes”, “traits”, and “DNA”: <https://www.youtube.com/watch?v=udCtpMZ95r0> (4:00 – 4:15).
 - We recommend projecting the image in their Student Guides and reviewing the new terms, “chromosome” and “alleles” using the image. We provide text in the Student Guide to introduce students to these terms.
 - Before moving on to the modeling activity, you may wish to check for understanding by having students practice using these terms to explain the image with a partner.
 - Take any clarifying questions.
- Pass out a “Genes Card” to each student. Each “Genes Card” should have a randomized set of alleles for their monster’s traits (Ex: HH tt ee).
 - Review the three main monster traits as a class: head shape (circular vs. square), mouth features (tongue out vs. teeth), and number of eyes (one eye vs. four eyes).
 - Students use their “Genes Card” and the Genetic Codebreaker in their Student Guides to figure out what traits their monster has.
 - We recommend projecting the Genetic Codebreaker and first modeling with an example, like the one shown below.
 - Students should record their alleles and traits in the data table in their Student Guide.
 - We also recommend giving students time to do a partner-check of their monsters’ traits before they move onto the mating part of the activity.

	Head Shape	Mouth Features	Number of Eyes
Alleles (Letters)	HH	tt	ee
Trait	Circular	Teeth	Four Eyes

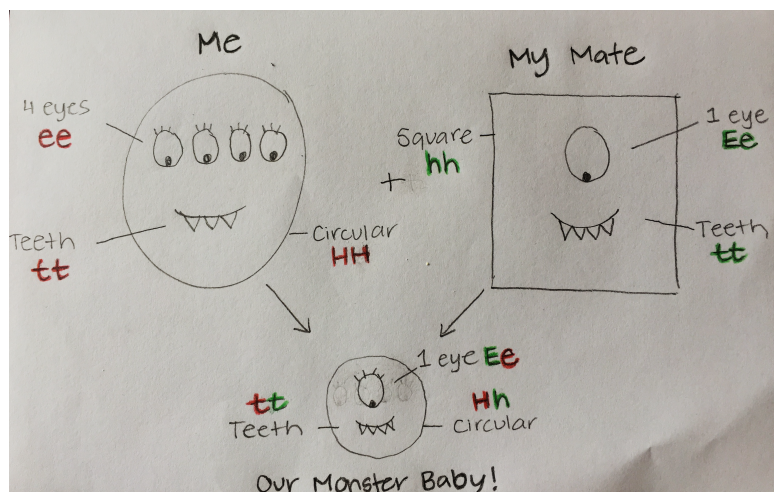
6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring

4. Now students are ready to find a mate and make a monster baby! You may assign partners or let students choose their own partner. Once students have found a partner, they should record their mate's alleles and traits in the data table in their Student Guides.
5. To decide what traits their monster offspring will have, they will use a paper bag and pipe cleaners of different lengths and colors, which represent alleles. Specific instructions are provided in their Student Guides.
 - For each pair of students, pass out 1 paper bag, 4 pipe cleaners of one color (2 short and 2 long), and 4 pipe cleaners of a different color (2 short and 2 long). The color allows students to distinguish which alleles belong to which parent monster. The length of the pipe cleaner allows them to tell whether it is a capital (long) or lowercase (short) letter.
 - For each of the three traits, each student will place two of their color pipe cleaners into the paper bag to represent their alleles (choosing short or long depending on their "Genes Card"). Without looking, they pull out one pipe cleaner allele of each color, repeating as necessary to get both colors. This yields the offspring's allele combination for that trait.
 - While all of the instructions are in the Student Guide, we highly recommend modeling this process first as it can be complicated for students.
6. Once students have mated with one partner, you may want them to repeat the process with that partner or multiple other partners, so they can see the variation that occurs.
 - Regardless of whether you have students do additional mating, we recommend conducting a brief class-wide discussion using the questions in their Student Guides: "Does your monster offspring have the exact same traits as you? The same as your mate?" This will prime them to begin thinking about the variation that occurs with sexual reproduction.

Explain

1. Now that students have kinesthetically modeled sexual reproduction, they can draw their own model to show exactly how it works. Encourage them to use the checklist in their Student Guides to guide them as they develop their models.
 - Here students are again using the SEP of **Developing and Using Models** to describe sexual reproduction and variation.
 - Optional: You may want to provide colored pencils during this activity because it can make it easier for students to show where different alleles are coming from (half from mom, half from dad).
 - A possible student sample is provided to the right:



6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring

2. Once students have drawn their models, they are introduced to the term “sexual reproduction” in their Student Guides. In this question at the bottom of this section, students are asked to use their model to think about why sexual reproduction creates offspring with genetic variation (different genes between parents and siblings).
 - This question emphasizes the CCC of **Cause and Effect** as students describe the cause and effect relationship of gene transmission from parents to offspring to explain the resulting variation.
3. We recommend students do this section individually so it can serve as a formative assessment of each student’s learning. Collect student work to identify trends in students’ ability to develop a model to show sexual reproduction and genetic variation. See “How to Use This Curriculum” for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.
4. Optional: To wrap up students’ understanding of sexual reproduction and introduce them to asexual reproduction, you may want to show this video after student models are complete: <https://learn.genetics.utah.edu/content/basics/inheritance/>

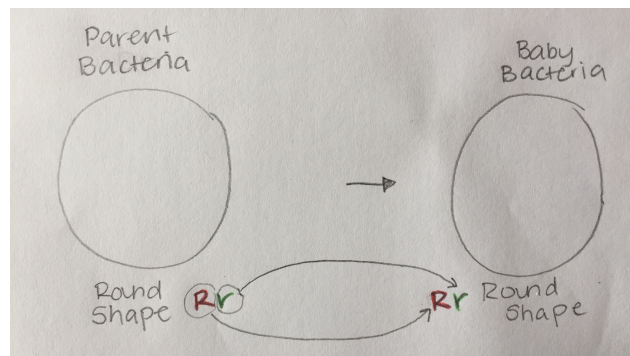
Elaborate

1. Students just modeled the process of sexual reproduction, but organisms, like the cyanobacteria in Blue-Green Algae, reproduce asexually. To explore this process, students use an abbreviated model, draw a new diagram for asexual reproduction, and compare it with their model for sexual reproduction.

2. Students start with one set of alleles for a shape gene: Rr (round). Pass out a paper bag and pipe cleaners in one color.
 - Each student places a short and long pipe cleaner into the bag and removes two pipe cleaners without looking to get their bacteria offspring’s allele combination.
 - Make sure students record this in their chart, shown below:

	Parent’s Trait	Baby’s Trait
Alleles (Letters)	Rr	Rr
Trait	Round	Round

- While this seems like a silly process, it represents what happens during asexual reproduction.
3. Like with sexual reproduction, students develop a model to show gene transmission in asexual reproduction, this time with a partner.
 - Here students are again using the SEP of **Developing and Using Models** to describe sexual reproduction and variation.
 - A possible student sample is provided to the right:



6th Grade Science Unit 3: Nature via Nurture**Task 4: From Parents to Offspring**

4. Once students have drawn their models, they can use the questions that follow to compare sexual reproduction and asexual reproduction, emphasizing why sexual reproduction creates genetic variation but asexual reproduction does not.
 - This again emphasizes the CCC of **Cause and Effect**, this time to describe the cause and effect relationship of gene transmission from parent to offspring to explain why there is no variation in asexual reproduction.
5. Share out responses to these last two questions in a class-wide discussion as a check for understanding. You may want to create a t-chart as students share out the differences between sexual and asexual reproduction.
 - Again, we encourage using equity sticks to foster more equitable participation in class-wide discussions like these (See “How To Use This Curriculum” for more details).
6. Return to the whole-class concept map from the Lift-Off Task.
 - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See “How To Use This Curriculum” for more details).
 - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
 - Draw circles around each question and boxes around each concept.
 - Write connector words to describe connections between the concept boxes.
 - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: sexual reproduction, asexual reproduction, and genetic variation.
 - Have students analyze the additions to the class concept map for as many examples of this task’s crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
 - **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.
 - Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 4 section of the Unit 3 Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.

6th Grade Science Unit 3: Nature via Nurture**Task 4: From Parents to Offspring**

2. Students have been asked to give a news story update on a local lake that is suffering from a recurring toxic algal bloom. Their prompt is as follows: An algal bloom refers to a large growth of algae, so we need to know how they actually reproduce!
 - ✓ Refer back to your model: How do cyanobacteria (blue-green algae) reproduce?
 - ✓ Does this better support the case for algal blooms being caused by genetics or environmental factors? Explain.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
 - At the beginning of this task, you were asked to think about why puppies look different than their dog parents, but bacteria look the same as their bacteria parent. Look back at your initial responses: Based on what you learned throughout this task, how could you better explain this?
 - In this task, we focused on the crosscutting concept of **Cause and Effect**: Cause and effect relationships can be used to predict phenomena, and phenomena may have more than one cause. Where did you see examples of **Cause and Effect** in this task?
 - Now that you have learned more about how different kinds of organisms reproduce, what questions do you still have?
2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. Collect students' Task 4 Student Versions and assess the *Explain* using the 3-Dimensional Task 4 Rubric below. To maintain the authenticity of the Culminating Project, the sexual reproduction aspect of MS-LS3-2 will be assessed through this task rather than within the Culminating Project. The asexual reproduction aspect of MS-LS3-2 will be assessed within the Culminating Project.
2. You may collect students' Project Organizer and assess using:
 - *Criteria of your choice*. We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
 - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.
3. You may also give students time to make revisions with one of the two options:
 - Students may make changes to their Project Organizer according to your comments OR
 - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

6th Grade Science Unit 3: Nature via Nurture

Task 4: From Parents to Offspring

Task 4 Rubric: Student develops a model to describe how “monsters” reproduce, which also describes the effect on genetic variation in offspring.

- Use to assess student model and response in the *Explain*.
- Dimensions Assessed: SEP – Developing and Using Models, DCI – LS1.B: Growth and Development in Organisms and LS3.A: Inheritance of Traits and LS3.B: Variation of Traits, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student develops an inaccurate model to describe how “monsters” reproduce.	Student develops a partial model to describe how “monsters” reproduce.	Student develops a complete model to describe how “monsters” reproduce, which also implicitly describes the effect on genetic variation in offspring.	Student develops a complete model to describe how “monsters” reproduce, which also explicitly describes the effect on genetic variation in offspring.
<p>Look Fors:</p> <ul style="list-style-type: none"> • Student draws an inaccurate model for reproduction in “monsters”. For example, the model shows “monsters” reproducing asexually, shows only one parent, or shows reproduction leading to no genetic variation. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows “monsters” reproducing sexually. Model includes two parents and one offspring that look different, and may or may not include labels of traits. • Student shows that parents and offspring have a different combination of traits, but does not include labels of alleles and thus does not explicitly show gene transmission. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows “monsters” reproducing sexually. Model includes two parents and one offspring, including labels of sample traits and alleles for each. • Student accurately shows that parents and offspring have a different combination of genes and traits. While student shows where each of the offspring’s alleles came from (using arrows or color-coding), they do not explicitly explain how this process results in genetic variation. 	<p>Look Fors:</p> <ul style="list-style-type: none"> • Student develops a model that accurately shows “monsters” reproducing sexually. Model includes two parents and one offspring, including labels of sample traits and alleles for each. • Student accurately shows and explicitly explains that parents and offspring have a different combination of genes and traits, showing exactly where each of the offspring’s alleles came from (using arrows or color-coding). • See sample model in <i>Explain</i> section above.

Note: An additional rubric is provided in the Culminating Project to assess asexual reproduction, since the organism in the Culminating Project reproduces asexually.