

Alignment of Activities with Next Generation Science Standards

(updated, June 2023)

Most of our activities for helping middle school and high school students learn life sciences are aligned with the Next Generation Science Standards (NGSS; <http://www.nextgenscience.org/next-generation-science-standards> and <http://www.nextgenscience.org/sites/default/files/HS%20LS%20topics%20combined%206.13.13.pdf>). The following tables summarize our activities that are explicitly aligned with NGSS Disciplinary Core Ideas and Performance Expectations. These tables also summarize how each of these activities engages students in Scientific Practices and provides the opportunity to discuss Crosscutting Concepts. Brief descriptions of these activities are compiled at <https://serendipstudio.org/exchange/bioactivities/NGSS/listing>. The Teacher Notes for each activity provide additional information concerning alignment with the Next Generation Science Standards.

Learning Activities for Disciplinary Core Idea (DCI) LS1.A - Structure and Function (Part 1)

These activities help to prepare students to meet **Performance Expectations** (PE):

- HS-LS1-2, "Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms."
- MS-LS1-2, "Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function."
- MS-LS1-3, "Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells."
- MS-LS1-8, "Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for" perception, "immediate behavior and/or storage as memories."

Activity ¹	Scientific Practices ²						Crosscutting Concepts ³		
	Model	Investigation	Data	Explain	Argue	Info	Mechanism	Models	Structure/Function
<u>Levels of Organization in Biology</u> (DCI:LS1.A; PE:HS-LS1-2) ⁴	+							+	

¹ For each activity, Student Handouts and Teacher Notes with instructional suggestions and background information are available at the link given.

² Model = Developing and Using Models; Investigation = Planning and Carrying out Investigations; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations and Designing Solutions; Argue = Engaging in Argument from Evidence; Info = Obtaining, Evaluating and Communicating Information

³ Mechanism = Cause and effect: Mechanism and explanation; Models = Systems and system models; Structure/Function = Structure and function

⁴ DCI = Disciplinary Core Idea; PE = Performance Expectation. Additional information is provided in the Teacher Notes (see footnote 1) and the Next Generation Science Standards website where you can use the search function to find more specifics.

<u>Introduction to Cells</u> (DCI: LS1.A; PE: MS-LS1-2)				+					+
<u>Structure and Function of Cells, Organs and Organ Systems</u> (DCI: LS1.A; PE: HS-LS1-2; MS-LS1-2, MS-LS1-3)				+					+
<u>Introduction to Osmosis</u> (DCI: LS1.A; PE: MS-LS1-2)		+	+	+			+		
<u>Cell Membrane Structure and Function</u> (DCI: LS1.A; PE: HS-LS1-2)	+		+	+				+	+
<u>How do we sense the flavors of food?</u> (DCI: LS1.A; PE: MS-LS1-8)		+	+	+	+		+		+
Activity	Model	Investigation	Data	Explain	Argue	Info	Mechanism	Models	Structure/Function
	Scientific Practices						Crosscutting Concepts		

Learning Activities for Disciplinary Core Ideas (DCI) LS1.A - Structure and Function (Part 2) and LS1.B - Growth and Development of Organisms

These activities help to prepare students to meet **Performance Expectations** (PE)

- HS-LS1-1, "Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells."
- HS-LS1-3. "Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis."
- HS-LS1-4, "Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing an say d maintaining complex organisms."

Activity	Scientific Practices ⁵						Crosscutting Concepts ⁶			
	Ask	Model	Investigation	Data	Explain	Argue	Models	Structure/ Function	Mechanism	Stability/ Change
<u>Introduction to the Functions of Proteins and DNA</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)					+			+		
<u>Enzymes Help Us Digest Food</u> (DCI: LS1.A; PE: HS-LS1-1)					+				+	
<u>DNA</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, MS-LS3-1)		+			+			+		
<u>DNA Structure, Function and Replication</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1)					+			+		

⁵ Ask = Asking Questions; Model = Developing and Using Models; Investigation = Planning and Carrying out Investigations; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations; Argue = Engaging in Argument from Evidence

⁶ Models = Systems and system models; Structure/Function = Structure and function; Mechanism = Cause and effect: Mechanism and explanation; Stability/Change = Stability and Change

Activity	Ask	Model	Investigation	Data	Explain	Argue	Models	Structure/ Function	Mechanism	Stability/ Change
<u>How Genes Can Cause Disease – Introduction to Transcription and Translation</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)		+			+			+	+	
<u>How Genes Can Cause Disease – Understanding Transcription and Translation</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)		+			+			+	+	
<u>Coronaviruses – What They Are and How They Can Make You Sick</u> (DCI: LS1.A; PE:HS-LS1-2)		+			+				+	
<u>COVID-19 Vaccines – How do they work?</u> (DCI: LS1.A; PE:HS-LS1-1)					+				+	
<u>UV, Mutations and DNA Repair</u> (DCI: LS1.A, LS3.B; PE: HS-LS3-2)			+	+	+					+
<u>Mitosis and the Cell Cycle – How a Single Cell Develops into the Trillions of Cells in a Human Body</u> (DCI: LS1.A, LS1.B, LS3.A; PE: HS-LS1-4, HS-LS3-1)		+			+		+		+	
<u>Mitosis and the Cell Cycle – How the Trillions of Cells in the Human Body Developed from a Single Cell</u>		+			+		+			

(DCI: LS1.B; PE: HS-LS1-4)										
<u>Meiosis and Fertilization – Understanding How Genes Are Inherited</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)		+			+		+		+	
<u>Understanding How Genes Are Inherited via Meiosis and Fertilization</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS- LS3-2)		+			+		+			
<u>Melanoma, Mutations and Abnormal Cell Cycles</u> (DCI: LS1.A, LS1.B; PE: HS-LS1-1, HS-LS1-4)					+				+	
<u>Cell Differentiation and Epigenetics</u> (DCI: LS1.B; PE: HS-LS1-4)					+				+	
<u>Negative Feedback, Homeostasis and Positive Feedback – Examples and Concepts</u> (DCI: LS1.A; PE: HS-LS1-3)	+*	+	+*		+					+
<u>Negative Feedback, Homeostasis, and Positive Feedback</u> (DCI: LS1.A; PE: HS-LS1-3)		+			+					+
Activity	Ask	Model	Investigation	Data	Explain	Argue	Models	Structure/ Function	Mechanism	Stability/ Change
	Scientific Practices						Crosscutting Concepts			

*In optional investigation

**Learning Activities for Disciplinary Core Idea (DCI) LS1.C - Organization for Matter and Energy Flow in Organisms
LS2.B – Cycles of Matter and Energy Transfer in Ecosystems**

These activities help to prepare students to meet **Performance Expectations (PE)**

- HS-LS1-5, "Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy."
- HS-LS1-6, "Construct and revise an explanation based on evidence for how carbon, hydrogen and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules."
- HS-LS1-7, "Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy."
- MS-LS2-3. "Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem."
- HS-LS2-3, "Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions."
- HS-LS2-4. "Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem."
- HS-LS2-5. "Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere and geosphere."
- HS-LS2-7. "Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity."

Activity	Scientific Practices ⁷							Crosscutting Concepts ⁸	
	Questions	Model	Investigation	Data	Math	Explain	Argue	Mechanism	Energy
<u>A Scientific Investigation – What types of food contain starch and protein?</u> (DCI: LS1.C; PE: HS-LS1-6)			+	+		+	+		+
<u>How do organisms use energy?</u> (DCI: LS1.C; PE: HS-LS1-7)						+			+

⁷ Questions = Asking Questions; Model = Developing and Using Models; Investigation = Planning and Carrying out Investigations; Data = Analyzing and Interpreting Data; Math = Using Mathematics; Explain = Constructing Explanations and Designing Solutions; Argue = Engaging in Argument from Evidence

⁸ Mechanism = Cause and effect: Mechanism and explanation; Energy = Energy and Matter: Flows, Cycles and Conservation

<u>Using Models to Understand Cellular Respiration</u> (DCI: LS1.C; PE: HS-LS1-7)		+				+			+
<u>Using Models to Understand Photosynthesis</u> (DCI: LS1.C; PE: HS-LS1-5)		+							+
<u>Photosynthesis, Cellular Respiration and Plant Growth</u> (DCI:LS1.C; PE: HS-LS1-6)		+		+		+			+
<u>Food, Energy and Body Weight</u> (DCI: LS1.C; PE: HS-LS1-7)	+				+	+		+	+
<u>How do muscles get the energy they need for athletic activity?</u> (DCI: LS1.C; LS2.B; LS1.A; PE: HS-LS1-7; HS-LS1-2)						+			+
<u>Photosynthesis and Cellular Respiration – Understanding the Basics of Bioenergetics and Biosynthesis</u> (DCI: LS1.C; PE: HS-LS1-5; HS-LS1-7; HS-LS2-5)		+				+		+	+
<u>Where does a tree's mass come from?</u> (DCI: LS1.C; PE: HS-LS1-6)				+		+	+	+	
<u>Photosynthesis Investigation</u> (DCI: LS1.C; PE: HS-LS1-5)	+		+	+		+			+
<u>Alcoholic Fermentation in Yeast – A Bioengineering Design Challenge⁹</u> (DCI: LS2.B; LS1.A; PE: HS-LS2-3)			+	+		+		+	
Activity	Questions	Model	Investigation	Data	Math	Explain	Argue	Mechanism	Energy
	Scientific Practices							Crosscutting Concepts	

⁹ Includes Engineering Practice = Designing solutions

<u>Food Webs, Energy Flow, Carbon Cycle and Trophic Pyramids</u> (DCI: LS2.B; PE: MS-LS2-3, HS-LS2-4, HS-LS2-5)		+					+			+
<u>Food Webs – Understanding What Happened When Wolves Returned to Yellowstone</u> (DCI: LS2.B, LS2.C; PE: HS-LS2-2)		+					+			
<u>Carbon Cycles and Energy Flow through Ecosystems and the Biosphere</u> (DCI: LS2.B; PE: HS-LS2-4, HS-LS2-5)		+					+			+
<u>Trophic Pyramids</u> (DCI: LS2.B; PE: HS-LS2-4)		+					+			+
<u>Food and Climate Change – How can we feed a growing world population without increasing global warming?</u> (DCI: LS2.B; PE: HS-LS2-4, HS-LS2-5, HS-LS2-7)							+	+	+	
Activity	Questions	Model	Investigation	Data	Math	Explain	Argue	Mechanism	Energy	
	Scientific Practices							Crosscutting Concepts		

**Learning Activities for Disciplinary Core Ideas (DCI) LS2.A – Interdependent Relationships in Ecosystems
LS2.C – Ecosystem Dynamics, Functioning and Resilience**

These activities prepare students to meet **Performance Expectations (PE)**

- MS-LS2-1, “Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.”
- MS-LS2-4, “Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.”
- HS-LS2-1, "Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems..."
- HS-LS2-2, "Use mathematical representations to support and revise explanations based on evidence about factors affecting... populations in ecosystems..."
- HS-LS2-6, "Evaluate the claims, evidence and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem."

Activity	Scientific Practices ¹⁰					Crosscutting concepts ¹¹		
	Model	Math	Data	Explain	Argue	Mechanism	Models	Stability/ Change
<u>Understanding and Predicting Changes in Population Size – Exponential and Logistic Population Growth Models vs. Complex Reality</u> (DCI: LS2.A, LS2.C; PE: HS-LS2-1, HS-LS2-2, HS-LS4-5)	+	+	+	+			+	+
<u>Some Similarities between the Spread of Infectious Disease and Population Growth</u> (DCI: LS2.A, LS2.C; PE: MS-LS2-1, MS-LS2-4, HS-LS2-1)	+		+	+		+	+	+
<u>Stability and Change in Biological Communities</u> (DCI: LS2.C; PE: HS-LS2-6)				+	+			+

¹⁰ Model = Developing and Using Models; Math = Using Mathematics and Computational Thinking; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations; Argue = Engaging in Argument from Evidence

¹¹ Mechanism = Cause and effect: Mechanism and explanation; Models = Systems and system models; Stability/Change = Stability and Change; Energy/Matter= Energy and Matter: Flows, Cycles and Conservation

Learning Activities for Disciplinary Core Idea (DCI) LS3A – Inheritance of Traits

These activities help to prepare students to meet **Performance Expectations (PE)**

- MS-LS3-1, "Develop and use a model to describe why structural changes to genes located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism."
- HS-LS3-1, "Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring."

Activity	Scientific and Engineering Practices ¹²					Crosscutting Concepts ¹³		
	Model	Investigation	Data	Explain	Argue	Mechanism	Models	Structure/ Function
<u>Mitosis and the Cell Cycle – How a Single Cell Develops into the Trillions of Cells in a Human Body</u> (DCI: LS1.A, LS1.B, LS3.A; PE: HS-LS1-4, HS-LS3-1)	+			+		+	+	
<u>Meiosis and Fertilization – Understanding How Genes Are Inherited</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)	+			+		+	+	
<u>Understanding How Genes Are Inherited via Meiosis and Fertilization</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)	+			+			+	
<u>Genetics</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2, HS-LS3-3)	+			+		+	+	
<u>Introduction to Genetics – Similarities and Differences between Family Members</u> (DCI: LS1.A, LS3.A; PE: HS-LS3-1, HS-LS3-2)	+			+		+		

¹² Model = Developing and Using Models; Investigation = Planning and Carrying out Investigations; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations; Argue = Engaging in Argument from Evidence

¹³ Mechanism = Cause and Effect: Mechanism and explanation; Models = Systems and System Models; Structure/Function = Structure and Function

<u>Soap Opera Genetics – Genetics to Resolve Family Arguments</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2, HS-LS3-3)	+			+	+	+		
<u>Were the babies switched? – The Genetics of Blood Types</u> (DCI: LS1.A, LS3.A; PE: HS-LS3-1)			+	+		+		
<u>Introduction to the Functions of Proteins and DNA</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)				+				+
<u>How Genes Can Cause Disease – Introduction to Transcription and Translation</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)	+			+		+		+
<u>How Genes Can Cause Disease – Understanding Transcription and Translation</u> (DCI: LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)	+			+		+		+
<u>Genetic Engineering Challenge - How can scientists develop a type of rice that could prevent vitamin A deficiency?</u> ¹⁴ (DCI: LS1.A, LS3.A; PE: HS-LS3-1)				+*		+		+
<u>Gene-Editing with CRISPR-Cas – A Cure for Severe Sickle Cell Anemia?</u> (DCI: LS1.A, LS3.A; PE: HS-LS3-1)				+		+		+
	Model	Investigation	Data	Explain	Argue	Mechanism	Models	Structure/ Function

¹⁴ Includes Engineering Practice = Designing solutions

Learning Activities for Disciplinary Core Idea (DCI) LS3B -Variation of Traits

These activities help to prepare students to meet **Performance Expectations (PE)**

- HS-LS3-2, "Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors."
- HS-LS3-3, "Apply concepts of statistics and probability to explain the variation in distribution of expressed traits in a population."

Activity	Scientific Practices ¹⁵						Crosscutting Concepts ¹⁶			
	Model	Investigation	Data	Explain	Argue	Info	Mechanism	Models	Structure/ Function	Stability/ Change
<u>Meiosis and Fertilization – Understanding How Genes Are Inherited</u> (DCI: LS1.A, LS1.B, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)	+			+			+	+		
<u>Understanding How Genes Are Inherited via Meiosis and Fertilization</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)	+			+				+		
<u>UV, Mutations and DNA Repair</u> (DCI: LS1.A, LS3.B; PE: HS-LS3-2)		+	+	+						+
<u>Genetics</u>	+			+			+	+		

¹⁵ Model = Developing and Using Models; Investigation = Planning and Carrying out Investigations; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations; Argue = Engaging in Argument from Evidence; Info = Obtaining, Evaluating and Communicating Information

¹⁶ Mechanism = Cause and effect: Mechanism and explanation; Models = Systems and system models; Structure/Function = Structure and Function; Stability/Change = Stability and change

(DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2, HS-LS3-3)										
<u>The Genetics of Sickle Cell Anemia and Sickle Cell Trait</u> (DCI:LS3.B; PE:HS-LS3-1)	+			+			+			
<u>Soap Opera Genetics – Genetics to Resolve Family Arguments</u> (DCI: LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2, HS-LS3-3)	+		+	+	+			+		
<u>Were the babies switched? – The Genetics of Blood Types</u> (DCI: LS1.A, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)		+	+	+	+				+	
<u>The Molecular Biology of Mutations and Muscular Dystrophy</u> (DCI:LS3.B; PE:HS-LS3-2)	+			+			+	+		
<u>A mistake in copying DNA can result in dwarfism.</u> (DCI: LS3.B; PE: HS-LS3-2)				+			+			
Activity	Model	Investigation	Data	Explain	Argue	Info	Mechanism	Models	Structure/ Function	Stability/ Change
	Scientific Practices						Crosscutting Concepts			

**Learning Activities for Disciplinary Core Ideas (DCI) LS4.A - Evidence of Common Ancestry and Diversity
 LS4.B - Natural Selection and
 LS4.C - Adaptation**

These activities prepare students to meet **Performance Expectations (PE)**

- MS-LS4-2, "Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms... to infer evolutionary relationships."
- MS-LS4-4, "Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment."
- MS-LS4-6, "Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time."
- HS-LS4-1, "Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence."
- HS-LS4-2, "Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment."
- HS-LS4-3, "Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait."
- HS-LS4-4, "Construct an explanation based on evidence for how natural selection leads to adaptation of populations"
- HS-LS4-5, "Evaluate the evidence supporting claims that changes in environmental conditions may result in increases in the number of individuals of some species..."

Activity	Scientific Practices ¹⁷				Crosscutting Concepts ¹⁸			
	Model	Data	Explain	Argue	Mechanism	Patterns	Scale, etc.	Stability/Change
<u>How Whales Evolved – Evidence and Scientific Arguments</u> (DCI: LS4.A; PE: HS-LS4-1)			+	+			+	

¹⁷ Model = Developing and Using Models; Math = Using Mathematics and Computational Thinking; Data = Analyzing and Interpreting Data; Explain = Constructing Explanations; Argue = Engaging in Argument from Evidence

¹⁸ Mechanism = Cause and effect: Mechanism and explanation; Patterns; Scale, etc. = Scale, Proportion and Quantity; Stability/Change = Stability and change

<u>How Eyes Evolved – Analyzing the Evidence</u> (DCI: LS4.A, LS4.C; PE: HS-LS4-1)		+	+	+			+	+
<u>How does evolution result in similarities and differences?</u> (DCI: LS4A, PE: MS-LS4-2)		+	+			+		
<u>Evolution by Natural Selection</u> (DCI: LS4.B, LS4.C; PE: MS-LS4-4, MS-LS4-6, HS-LS4-2, HS-LS4-3, HS-LS4-4)	+	+	+		+			+
<u>What is natural selection?</u> (DCI: LS4.C; PE: HS-LS4-4)			+		+			+
<u>Natural Selection and the Peppered Moth</u> (DCI: LS4.B, LS4.C; PE: HS-LS4-4)		+	+		+			+
<u>Evolution of Fur Color in Mice – Mutation, Environment and Natural Selection</u> (DCI: LS4.B, LS4.C; PE: HS-LS4-2, HS-LS4-4)				+	+			+
<u>Coronavirus Evolution and the COVID-19 Pandemic</u> (DCI: LS4.B, LS4.C; PE: HS-LS4-3)	+		+					+
<u>Using Molecular and Evolutionary Biology to Understand HIV/AIDS and Treatment</u> (DCI: LS3.A LS4.B; PE: HS-LS4-4)			+		+			+
<u>Evolution and Adaptations</u> (DCI: LS4.B, LS4.C; PE: HS-LS4-4)		+	+	+	+			+
<u>The Ecology of Lyme Disease</u> (DCI: LS4.C; PE: HS-LS4-5)		+	+	+				+
Activity	Scientific Practices				Crosscutting Concepts			
	Model	Data	Explain	Argue	Mechanism	Patterns	Scale, etc.	Stability/ Change