



# Burlington County Institute of Technology

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Medford Campus

Westampton Campus

## **Biology**

Department: Science

Credits: 5

Revised: August 2023

Board Approval Date: August, 2023



# Course Description

This comprehensive course in biology provides students with a fundamental understanding of life's diverse forms, processes, and interrelationships. Through an exploration of key biological concepts and principles, students will develop a solid foundation in the field of biology, enabling them to comprehend the complexity of living organisms and their interactions with the environment. This course emphasizes the scientific method, critical thinking, and inquiry-based learning to foster a deeper understanding of the biological world.

This comprehensive course in biology explores the intricacies of life and its processes through five key units. The first unit focuses on the structure and function of living organisms, examining their organization at various levels and the relationship between form and function. In the second unit, students delve into energy flow and cell biology, exploring how energy is harnessed and transformed within cells. The third unit delves into ecology and interdependence, investigating the dynamic interactions between organisms and their environment. The fourth unit delves into genetics, inheritance, and the variation of traits, exploring the molecular basis of inheritance and the mechanisms that contribute to the diversity of species. Finally, the fifth unit explores natural selection and evolution, studying the evidence and mechanisms behind the ongoing processes that shape life's diversity.

Throughout the course, students will engage in hands-on laboratory investigations, scientific inquiry, and data analysis to reinforce concepts and develop essential laboratory skills. Critical thinking, problem-solving, and effective communication of scientific ideas will be emphasized. By the end of the course, students will have gained a deep appreciation for the interconnectedness of life and the importance of biology in understanding and addressing real-world challenges.



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# Pacing Guide

Unit	Standards	Days
Unit 1: Structure and Functions	HS-LS1-1, 2, 3 HS-PS3-5	14
Unit 2: The Cell and Energy	HS-LS1-5, 6, 7 HS-LS2-3, 4, 5	27
Unit 3: Inheritance and Variation of Traits	HS-LS1-1, 4 HS-LS3-1, 2, 3 HS-PS4-2, 5	18
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# Curriculum Maps

## Unit 1: Structure and Function

### Desired Outcomes

#### **NJSLS**

##### Life Science (LS)

- 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-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

##### Physical Science (PS)

- HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

#### **Established Goals**

- Students will use models to identify the various elements that make up carbohydrates, lipids, proteins and nucleic acids.
- Describe the importance of carbohydrates, lipids, proteins and nucleic acids. 3. Identify where biological molecules are located within an organism.
- Compare and contrast active and passive transport.

- Identify the various components of the cell membrane involved in both active and passive transport.
- Explain how the process of active and passive transport helps an organism to maintain homeostasis.
- Identify the role of mRNA, rRNA and tRNA in protein synthesis.
- Describe how the structure of DNA determines which protein is being made.
- Develop a model to show how cells, tissues, organs and organ systems are used to comprise the overall structure of multicellular organisms.
- Examine how the levels of organization within a living thing interact with one another to maintain an organism.
- Understand how a model relates to actual interactions that occur in an organism.
- Describe examples that show how various stimuli brings about responses within an organism.
- Understand that organisms are subject to both external and internal stimuli in maintaining homeostasis.
- Design an investigation that illustrates the relationship between stimulus and response.
- Develop a model of the interaction of electric forces in two polar compounds, and two non-polar compounds.

<b><i>Science and Engineering Practices</i></b>	<b><i>Disciplinary Core Ideas</i></b>	<b><i>Crosscutting Concepts</i></b>
<b>Constructing Explanations and Designing Solutions</b> Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.	<b>LS1.A: Structure and Function</b> <ul style="list-style-type: none"> <li>• Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)</li> <li>• All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out</li> </ul>	<b>Structure and Function</b> <ul style="list-style-type: none"> <li>• Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)</li> </ul>

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-1)

### **Developing and Using Models**

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
- Develop and use a model based on evidence to illustrate the relationships between systems or between

most of the work of cells. (HS-LS1-1)

- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

### **PS3.C: Relationship Between Energy and Forces**

- When two objects interacting through a field change relative position, the energy stored in the field is changed. (HS-PS3-5)

### **Systems and System Models**

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2), (HS-LS1-4)

### **Stability and Change**

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

### **Cause and Effect**

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS3-5)

components of a system.  
(HS-PS3-5)

### Planning and Carrying Out Investigations

Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.  
(HS-LS1-3)

### Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientific inquiry is characterized by a common set of values that include: logical thinking, precision,



open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

### **Enduring Understandings:**

- All organisms transfer matter and convert energy from one form to another.
- Matter and energy are necessary in building and maintaining structures within an organism.
- Knowledge about life processes can be applied to improving human health and well being.

### **Essential Questions:**

- How do organisms live and grow?
- What controls the movement of substances into and out of the cell?
- How do structures of organisms enable life's functions?

### **Students will know:**

- Biomolecules – proteins, carbohydrates, lipids, nucleic acids
- Transport – active and passive transport
- Levels of organization: cells → tissues → organs → organ system
- Homeostasis

### **Students will be able to:**

- Represent and explain the relationship between the structure and function of each class of complex molecules using a variety of models.
- Predict organism or individual cell's response in a given set of environmental conditions.
- Gather and analyze data as it relates to a stimulus response relationship.
- Explain the connection between the sequence and the subcomponents of a biomolecule and its properties.
- Construct models that explain the movement of



molecules across membranes with membrane structure and function.

- Create representations that explain how genetic information flows from a sequence of nucleotides in a gene to a sequence of amino acids in a protein.
- Provide examples and explain how organisms use feedback systems to maintain their internal environments.

### **Assessment Evidence**

#### **Suggested Performance Tasks:**

- Macromolecule Models
- Carbohydrate Test
- Calories in food – burn to determine energy in different foods.
- Diffusion/Osmosis – Modeling Transport – Egg Lab
- Diffusion – cornstarch, iodine
- Enzyme Lab – liver/hydrogen peroxide
- Active Transport
- Levels of Organization

#### **Required District/State Assessments:**

- District marking period assessments
- SGO assessments

#### **Suggested Formative/Summative Assessments:**

- Lab/activity report
- Practice Worksheets
- Section Quizzes
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations



- Warmups / exit tickets

## Learning Plan

### Learning Activities:

- Guided reading and or notes.
- Science articles relating to this unit's topic

## Related Standards

### Interdisciplinary connections

- ELA Connections
  - ⇒ RI.9-10.1
    - Example: Cite specific textual evidence that supports how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
    - Example: Write an explanation that supports how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
  - ⇒ NJSLSA.W9
    - Example: Draw evidence from informational texts to support how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
  - ⇒ NJSLSA.SL5
    - Example: Make strategic use of digital media in presentations to enhance understanding of the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
  - ⇒ NJSLSA.W7
    - Example: Conduct short as well as more sustained research to determine how feedback mechanisms maintain homeostasis. Synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.



⇒ NJSLA.W8

- Example: Gather applicable information from multiple reliable sources to support claims that feedback mechanisms maintain homeostasis. Use advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

### **21st Century Skills (NJSL Career Readiness, Life Literacies, and Key Skills - Technology Literacy)**

- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
  - ⇒ Example: Students will organize lab data utilizing Google Sheets. Results will be analyzed utilizing formulas and summarized with the appropriate chart.
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
  - ⇒ Example: Students will work with lab partners or teams in which all individuals positively contribute. Lab partners apply awareness of cultural differences to avoid barriers to productive and positive interactions. Students plan and facilitate effective team work to find ways to increase the engagement and contribution of all team members.

### **NJ SEL Competencies**

- Relationship Skills: Identify who, when, where, or how to seek help for oneself or others when needed
- Social Awareness: Demonstrate an understanding of the need for mutual respect when viewpoints differ

### **Culturally Relevant Connections**

- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tools such as Zoom, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Structure the learning around explaining or solving a social or community-based issue.



- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

## Accommodations

### **Special Education/ 504/ At Risk Students** **Accommodations & Modifications:**

- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

### **ELL:**

- Provide multiple literacy strategies
- Use of word/picture walls in the classroom displaying a list of key academic vocabulary words for reference (from a specific unit).
- Provide graphic organizers
- Provide students with visuals aids like pictures and diagrams to illustrate the structure of a multicellular organism.
- Have students work in triads or small groups where they are able to support each other's learning by giving each other input and filling in gaps in background. Students often work best when they have defined roles (surrounding the content they are studying) that they are responsible for.
- Incorporate writing activities such as science journals to support the acquisition of academic language in science and to empower students with a resource for later reference.

## Enrichment

- [DNA, RNA, and Snorks](#): In this simulation, you will examine the DNA sequence of a fictitious organism - the Snork. Snorks were discovered on the planet Dee Enae in a distant solar system. Snorks only have one chromosome with eight genes on it. Your job is to analyze the genes of its DNA and determine what traits the



organism has and then sketch the organism.



## Unit 2: Energy and Cell

### Desired Outcomes

#### **NJSLS**

##### Life Science (LS)

- 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.
- 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 mathematical representations 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.

#### **Established Goals**

1. Use visual representations to illustrate how interactions among living systems and with their environment result in the movement of matter and energy.
2. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
3. 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.

4. 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
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.
6. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
7. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

<b><i>Science and Engineering Practices</i></b>	<b><i>Disciplinary Core Ideas</i></b>	<b><i>Crosscutting Concepts</i></b>
<b>Developing and Using Models</b> Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. <ul style="list-style-type: none"> <li>• Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7)</li> <li>• Construct and revise an explanation based on valid and reliable evidence</li> </ul>	<b>LS1.C: Organization for Matter and Energy Flow in Organisms</b> <ul style="list-style-type: none"> <li>• The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)</li> <li>• The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to</li> </ul>	<b>Energy and Matter</b> <ul style="list-style-type: none"> <li>• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)</li> <li>• Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7), (HS-LS2-4)</li> <li>• Energy drives the cycling of matter within and between systems. (HS-LS2-3)</li> </ul>



obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-6)

- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

### Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions

- Use mathematical

form new cells. (HS-LS1-6)

- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

### LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life

### Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5)

representations of phenomena or design solutions to support claims. (HS-LS2-4)

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS2-3)

processes. (HS-LS2-3)

- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the

	biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)  <b>PS3.D: Energy in Chemical Processes</b> <ul style="list-style-type: none"> <li>The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)</li> </ul>	
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### **Enduring Understandings:**

Students will understand that...

- Photosynthesis and cellular respiration are complementary processes necessary to the survival of most organisms on Earth.
- The primary source of energy to sustain most life is derived from a conversion of light energy to chemical energy through the process of photosynthesis.

### **Essential Questions:**

- How do living organisms grow, respond to their environment, and reproduce?  
How and why do organisms interact with their environment and what are the effects of these interactions?
- How is energy transferred and conserved?

### **Students will know:**

- Photosynthesis
- Cellular Respiration

### **Students will be able to:**

- Distinguish between the process of photosynthesis and cellular respiration.



- Energy
- Carbon Cycle
- Food is used to provide energy for the work that cells do.

Concepts:

1. Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
2. Energy drives the cycling of matter within and between systems in aerobic and anaerobic conditions.
3. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
4. The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis

- Explain the process of photosynthesis
- Describe the process of cell respiration, including reactants and products, glycolysis, the krebs cycle, and the electron transport chain.
- Distinguish between aerobic and anaerobic respiration.
- Understand the concept of energy and its contributions to maintaining life on Earth.
- Distinguish among the different forms of energy.
- Describe the laws of thermodynamics.
- Distinguish between endergonic and exergonic reactions.
- Distinguish between oxidation and reduction reactions.

## Assessment Evidence

### **Suggested Performance Tasks:**

- [How do biological organisms use energy?](#) (LS1.C; PE: HS-LS1-7)
- [Using Models to Understand Photosynthesis](#) (LS1.C, LS2.B; PE: HS-LS1-5, HS-LS1-7, HS-LS2-5)
- [Photosynthesis Investigation](#) (LS1.C; PE:

### **Required District/State Assessments:**

- District marking period assessments
- SGO assessments

### **Suggested Formative/Summative Assessments:**

- Lab/activity report



- HS-LS1-5)
- [Where does a plant's mass come from?](#) (LS1.C; PE: HS-LS1-5)
- [Plant Growth Puzzle](#) (LS1.C; PE: HS-LS1-5, and HS-LS1-7)
- [How do muscles get the energy they need for athletic activity?](#) (LS1.C; PE: HS-LS1-7)
- [Food, Energy, and Body Weight](#) (LS1.C; PE: HS-LS1-7)
- [Alcoholic Fermentation in Yeast](#) - A Bioengineering Design Challenge (LS2.B; PE: HS-LS1-7)
- [Research Story: A Modern Scientist-Engineer in the World of Fermentation](#)
- [Fermentation Challenge: Making Ethanol from Cellulose](#)

- Practice Worksheets
- Section Quizzes
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

## Learning Plan

### **Learning Activities:**

- Class Discussions
- Teacher facilitated inquiry (various inquiry levels)
- Teacher Demonstrations
- Student research for planning lab investigations
- Learning Stations
- Group Collaboration
- In-Class Skill Practice
- The use of various instructional practices tailored to the learning needs of the class (Project Based Instruction, Cooperative Learning, Socratic Questioning, etc.)



## Related Standards

### **Interdisciplinary connections**

- ELA Connections
  - ⇒ NJSLSA.W7
    - Example: Conduct short as well as more sustained research to determine how various factors affect the rate of photosynthesis. Synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
  - ⇒ NJSLSA.W8
    - Example: Gather applicable information from multiple reliable sources to support claims that the mechanisms of cellular respiration are used in the treatment of poisons.. Use advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
  - ⇒ NJSLSA.W9
    - Example: Draw evidence from informational texts to support how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.

### **NJ SEL Competencies**

- Self-Awareness: Recognize one's personal traits, strengths, and limitations
- Self-Management: Recognize the skills needed to establish and achieve personal and educational goals

### **Climate Change**

- [Cougars and Trees in a Trophic Cascade](#) - In this activity, students analyze and interpret two graphs from a study that investigated the ecosystem effects of the displacement of cougars in a national park.
- Students are tasked with describing how changes in one population in an ecosystem can affect other populations through a trophic cascade.



## Culturally Relevant Connections

- Provide opportunities for students to connect with people of similar backgrounds (i.e. conversations via digital tools such as Zoom, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (i.e. multiple representation and multimodal experiences).
- Structure the learning around explaining or solving a social or community-based issue.
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

## Accommodations

### **Special Education/ 504/ At Risk Students** **Accommodations & Modifications:**

- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques- auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

### **ELL:**

- Provide multiple literacy strategies
- Use of word/picture walls in the classroom displaying a list of key academic vocabulary words for reference (from a specific unit).
- Provide graphic organizers
- Provide students with visual aids like pictures and diagrams to illustrate the processes within an organism's cells.
- Have students work in small groups where they are able to support each other's learning by giving each other input and filling in gaps in background.
- Students often work best when they have defined roles (surrounding the content they are studying) that they are responsible for.
- Incorporate writing activities such as science journals to support the acquisition of academic language in science and to empower students



with a resource for later reference.

### Enrichment

- Extended learning goals:
  - ⇒ [Cellular Respiration Gizmos STEM Case](#): Students will apply knowledge of cellular respiration from the point of view of a medical toxicologist to see how cellular respiration is involved in saving the life of a CIA agent that was poisoned.





## Unit 3: Inheritance and Variation of Traits

### Desired Outcomes

#### **Established Goals: NJSL**

##### Life Science (LS)

- 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-LS1-4 – Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- 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.
- HS-LS3-2 – Make and defend a claim based on evidence that inheritable genetic variations may result from: new genetic combinations through meiosis, viable errors occurring during replication, and/or 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

##### Physical Science (PS)

- HS-PS4-2 - Evaluate questions about the advantages of using digital transmission and storage of information.
- HS-PS4-5 - Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

#### **Established Goals:**

- Compare the products of meiosis and mitosis.
- Explain how the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity necessary for evolution.
- Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- 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.
- 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.
- Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

<b><i>Science and Engineering Practices</i></b>	<b><i>Disciplinary Core Ideas</i></b>	<b><i>Crosscutting Concepts</i></b>
<b>Developing and Using Models</b> Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds <ul style="list-style-type: none"> <li>● Use a model based on evidence to illustrate the</li> </ul>	<b>LS1.A: Structure and Function</b> <ul style="list-style-type: none"> <li>● Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)</li> <li>● All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of</li> </ul>	<b>Systems and System Models</b> <ul style="list-style-type: none"> <li>● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)</li> </ul>

relationships between systems or between components of a system. (HS-LS1-4)

### Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. (HS-LS1-1)

### Asking Questions and Defining Problems

Asking questions and defining

proteins, which carry out most of the work of cells. (HS-LS1-1)

### LS1.B: Growth and Development of Organisms

- In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

### LS1.A: Structure and Function

- All cells contain genetic information in the form of DNA molecules. Genes are

### Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

### Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2)

### Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

### Connections to Nature of Science

- Science is a Human Endeavor  
Technological advances have influenced the progress of

problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

### Analyzing and Interpreting Data

Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

### Engaging in Argument from Evidence

Engaging in argument from evidence in 9-12 builds on K-8

regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1)

### LS3.A: Inheritance of Traits

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

### LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis

science and science has influenced advances in technology. (HS-LS3-3)

- Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

<p>experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.</p> <ul style="list-style-type: none"> <li>• Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)</li> </ul>	<p>(cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)</p> <ul style="list-style-type: none"> <li>• Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)</li> </ul>	
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### **Enduring Understandings:**

- All living organisms have life cycles and reproduce.
- The characteristics of organisms are influenced by heredity and environment.
- The instructions for forming species'

### **Essential Questions:**

- How do organisms live, grow, respond to their environment, and reproduce?
- How are characteristics of one generation passed to the next?
- How can individuals of the same species and even



characteristics are carried in DNA.

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.
- The molecular structure of the DNA molecule is consistent in all living things and similar in members of a species
- Variance in the sequence of DNA bases in an organism gives it unique characteristics.
- The information in DNA provides instructions for assembling protein molecules in cells.
- Asexual reproduction produces offspring that have the same genetic code as the parent and leads to less variation in a species.
- Sexual reproduction produces offspring with a mixture of DNA increasing the genetic variation of an organism, and therefore, the species.

siblings have different characteristics?

**Students will know:**

- Cell Division
- Inheritance of Traits
- Variation of Traits
- Hereditary information is contained in genes, located in the chromosomes of most cells.
- A human cell contains many thousands of different genes.
- One or more genes can determine an inherited

**Students will be able to:**

- Describe Mendelian inheritance.
- Differentiate between dominant and recessive alleles.
- Define the terms homozygous, heterozygous, genotype, and phenotype.
- Discuss Mendel's laws of inheritance.
- Diagram and predict the results of mono and dihybrid crosses.

trait of an individual, and a single gene can influence more than one trait.

**Concepts:**

- All cells contain genetic information in the form of DNA molecules.
- Genes are regions in the DNA that contain the instructions that code for the formation of proteins.
- Each chromosome consists of a single, very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.
- The instructions for forming species' characteristics are carried in the DNA.
- All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.
- Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have, as yet, no known function.
- Empirical evidence is required to differentiate between cause and correlation and to make claims about the role of DNA and chromosomes in coding the instructions for the characteristic traits passed from parents to offspring.
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.
- Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in
  - Identify the effects of multiple alleles, codominance, and incomplete dominance on phenotype.
  - Identify the components of DNA and RNA.
  - Describe how the structure of DNA and RNA are related to their functions.
  - Describe the process of DNA replication.
  - Describe the process of transcription.
  - Recognize the steps involved in RNA processing.
  - Distinguish among messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA).
  - Describe the process of translation.
  - Recognize that cells can control gene expression.
  - Recognize various causes, types and effects of mutations.
  - Describe the causes and symptoms of various genetic disorders.
  - Recognize examples of autosomal dominant, autosomal recessive and sex-linked disorders in humans.
  - Describe the uses, benefits, and risks of genetic testing and gene therapy.
  - Recognize an example of genetic engineering.
  - Model cell division in eukaryotic organisms.
  - Compare and contrast sexual and asexual reproduction.
  - Describe the use of technology in mapping a genome and the use of digital transmission/storage of data.
  - Recognize the use of wave devices in medical treatments for cancer and other diseases.



mutations, which are also a source of genetic variation.

- Environmental factors can also cause mutations in genes, and viable mutations are inherited.
- Environmental factors also affect expression of traits, and hence affect the probability of occurrence of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.
- Algebraic thinking is used to examine scientific data and predict the distribution of traits in a population as they relate to the genetic and environmental factors (e.g., linear growth vs. exponential growth).
- Technological advances have influenced the progress of science, and science has influenced advances in technology.
- Science and engineering are influenced by society, and society is influenced by science and engineering.

## Assessment Evidence

### **Suggested Performance Tasks:**

- [Mitosis: How Each New Cell Gets a Complete Set of Genes](#) (LS1.A, LS1.B, LS3.A; PE: HS-LS1-4, HS-LS3-1)
- Mitosis Flip Book iPad App
- [Meiosis and Fertilization: Understanding How Genes Are Inherited](#) (LS1.A, LS1.B, LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2)

### **Required District/State Assessments:**

- District marking period assessments
- SGO assessments

### **Suggested Formative/Summative Assessments:**

- Lab/activity report
- Practice Worksheets





- [Genetics Activity](#) (LS1.A, LS3.A, LS3.B; HS-LS3-1, HS-LS3-2, HS-LS3-3)
- [DNA Activity](#) (LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)
- [DNA Structure, Function, and Replication](#) (LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)
- [Genetic Engineering Challenge - How can scientists develop a type of Rice that could prevent vitamin A deficiency?](#) (LS1.A, LS3.A; PE: HS-LS3-1)
- [From Gene to Protein - Transcription and Translation](#) (LS1.A, LS3.A, LS3.B; PE: HS-LS1-1, HS-LS3-1)
- [Learning Activity: Understanding the Functions of Proteins and DNA](#) (LS1.A, LS3.A; PE: HS-LS1-1, HS-LS3-1)
- [Soap Opera Genetics – Genetics to Resolve Family Arguments](#) (LS3.A, LS3.B; PE: HS-LS3-1, HS-LS3-2, HS-LS3-3)
- [The Molecular Biology of Mutations and Muscular Dystrophy](#) (LS3.B; PE: HS-LS3-2)
- Genetics Disorder Project

- Section Quizzes
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

## Learning Plan

### **Learning Activities:**

- Class Discussions
- Teacher facilitated inquiry (various inquiry levels)
- Teacher Demonstrations
- Student research for planning lab investigations
- Learning Stations
- Group Collaboration
- In-Class Skill Practice



- The use of various instructional practices tailored to the learning needs of the class (Project Based Instruction, Cooperative Learning, Socratic Questioning, etc.)
- 5E Model Learning Progression (engage, explore, explain, elaborate, evaluate)

## Related Standards

### **Interdisciplinary connections**

- English Language Arts
  - ⇒ NJSLSA.R8 (Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.)
    - Example: Write arguments, based on evidence, that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors.
  - ⇒ NJSLSA.R1. (Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.)
    - Example: Have students read an article and have them determine what the author's message is and how it connects with the content being discussed in class.
  - ⇒ NJSLSA.R2. (Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.)
    - Example: Have students read an article and have them summarize the article and present supporting details about the central idea presented in the article.
- Mathematics
  - ⇒ S.ID.B.6a (Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.)
    - Example: Represent symbolically evidence that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors, and manipulate the representing symbols. Make sense of quantities and relationships to describe and predict the ways in which inheritable genetic variation occurs.
  - ⇒ S.ID.B.6a (Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic,



and exponential models.)

- Example: Represent the variation and distribution of expressed traits in a population symbolically and manipulate the representing symbols. Make sense of quantities and relationships to describe and predict the variation and distribution of expressed traits in a population.

### **NJ SEL Competencies**

- Self-Management: Recognize the skills needed to establish and achieve personal and educational goals
- Responsible Decision-Making: Evaluate personal, ethical, safety, and civic impact of decisions

### **Culturally Relevant Connections**

- Discuss that contributions to science occur from a variety of sources. Read an article about Henrietta Lacks. Her contribution to science is far reaching and her cells were taken and used for research without her knowing.
- Consider framing a genetics unit not around Gregor Mendel, but around researchers of color or a female:
  - ⇒ Priya Moorjani, a geneticist who has used genomic data to understand the origins of the Indian caste system
  - ⇒ Kono Yasui, a biologist who researched the genetics of several plant species
  - ⇒ Rick Kittles who used genetics to trace the ancestry of African Americans.
  - ⇒ Barbara McClintock who was not encouraged personally or professionally to study science, but who still went on to win the Nobel Prize for her work in genetics.

### **Accommodations**

#### **Special Education/ 504/ At Risk Students Accommodations & Modifications:**

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how

#### **ELL:**

- Provide students with multiple literacy strategies.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Emphasize visual literacy through the use of



they can represent their understandings (e.g. multisensory techniques - auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

graphic organizers, charts, graphs, figures, models and video.

- Think/Pair/Share activities pairing an English language learner with a strong English speaker.

### Enrichment

- Extended learning goals:
  - ⇒ Gizmo: Meowsis STEM Case. As a geneticist in an animal hospital, students learn about genetic changes in meiosis to determine the reason why a male cat can have calico fur coloring.
  - ⇒ Gizmo: Protein Synthesis - STEM case. As a pediatrician, students learn about genes and protein synthesis to try to help a baby girl named Lucy who has an immunodeficiency disease.



## Unit 4: Natural Selection and Evolution

### Desired Outcomes

#### **Established Goals: NJSL**

##### Life Science (LS)

- 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...the heritable genetic variation of individuals...competition for limited resources, and... 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, the emergence of new species over time, and the extinction of other species.

#### **Established Goals:**

- Examine a group of related organisms using a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic tree.
- Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- Make predictions about the effects of artificial selection on the genetic makeup of a population over time.
- 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.
- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- Evaluate the evidence for the role of group behavior on individual and species' chances to survive and

reproduce.

- Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- 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.

<b>Science and Engineering Practices</b>	<b>Disciplinary Core Ideas</b>	<b>Crosscutting Concepts</b>
<p><b>Analyzing and Interpreting Data</b> Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.</p> <ul style="list-style-type: none"> <li>• Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)</li> </ul> <p><b>Constructing Explanations and Designing</b></p>	<p><b>LS4.A: Evidence of Common Ancestry and Diversity</b></p> <ul style="list-style-type: none"> <li>• Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)</li> </ul> <p><b>LS4.B: Natural Selection</b></p>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3)</li> </ul> <p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6)</li> </ul> <p><b>Connections to Nature of Science</b></p>

<p>Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student generated sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> <li>Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. (HS-LS4-2),(HS-LS4-4)</li> </ul> <p><b>Engaging in Argument from Evidence</b> Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may</p>	<ul style="list-style-type: none"> <li>Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)</li> <li>The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)</li> </ul> <p><b>LS4.C: Adaptation</b></p> <ul style="list-style-type: none"> <li>Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment’s limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and</li> </ul>	<p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> <li>Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1),(HS-LS4-4)</li> </ul>
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<p>also come from current or historical episodes in science.</p> <ul style="list-style-type: none"> <li>Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)</li> </ul> <p><b>Obtaining, Evaluating, and Communicating Information</b></p> <p>Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.</p> <ul style="list-style-type: none"> <li>Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)</li> </ul> <p><b>Connections to Nature of Science</b></p> <p>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</p> <ul style="list-style-type: none"> <li>A scientific theory is a substantiated explanation of</li> </ul>	<p>reproduce in that environment. (HS-LS4-2)</p> <ul style="list-style-type: none"> <li>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)</li> <li>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</li> <li>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the</li> </ul>	
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some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5),(HS-LS4-6)

- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

#### **LS4.D: Biodiversity and Humans**

- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to

	supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6)	
<b><u>Enduring Understandings:</u></b> <ul style="list-style-type: none"><li>○ Evolution is the change in the genetic makeup of a population over time.</li><li>○ Organisms are linked by lines of descent from common ancestry.</li><li>○ Life continues to evolve within a changing environment.</li><li>○ The origin of living systems is explained by natural processes.</li><li>○ Evolution provides the central scientific understanding of the history of the modern world.</li><li>○ Evolutionary processes allow some species to survive through long term Earth changes, while leading to extinction of others.</li><li>○ Organisms that inherit characteristics advantageous for survival in their physical environment reproduce and increase the proportion of individuals with similar traits in the species.</li></ul>	<b><u>Essential Questions:</u></b> <ul style="list-style-type: none"><li>○ How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms?</li><li>○ How does biodiversity affect humans?</li><li>○ How do the structures of organisms enable life's functions?</li></ul>	
<b><u>Students will know:</u></b>	<b><u>Students will be able to:</u></b>	

- Evidence of Common Ancestry and Diversity
- Natural Selection
- Adaptation
- Speciation
- Probability and Population Trends
- Scientists consider a variety of evidence in order to classify organisms into three domains and six kingdoms.
- Molecular evidence substantiates the anatomical evidence for evolution and provides additional detail about the sequence in which various lines of descent branched.
- Modern ideas about evolution provide a scientific explanation for the history of life on Earth.

#### Concepts:

- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Empirical evidence is required to differentiate between cause and correlation and make claims about how natural selection leads to adaptation of populations.
- Empirical evidence is required to differentiate between cause and correlation and make claims

- Explain why and how scientists classify organisms.
- Distinguish among the three domains of life.
- Identify the characteristics of Domains Archaea and Bacteria
- Distinguish among the kingdoms in Domain Eukarya.
- Recognize the sequence of life on Earth and trace the evolution of plants and animals, including humans.
- Define the terms biological diversity, episodic speciation, and mass extinction.
- Label an evolutionary tree diagram.
- Explain aspects of the fossil record such as gaps and the sequential nature of fossils.
- Identify living and nonliving characteristics of viruses.
- Distinguish among different types of viruses based on genetic material and infection method.
- Describe the effect of viruses on humans.
- Recognize evidence of evolution including fossils, comparative morphology, development and molecular sequences.
- Recognize the contribution of Charles Darwin.
- Distinguish between artificial and natural selection.
- Define the unit of evolution and the Hardy-Weinberg equilibrium.
- Use the Hardy-Weinberg equation to predict the frequency of genotypes in a population.
- Identify processes of evolution, including mutation, bottleneck effect, founder effect, and sexual selection.

about how specific biotic and abiotic differences in ecosystems contribute to change in gene frequency over time, leading to adaptation of populations.

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future.
- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.
- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Adaptation also means that the distribution of traits in a population can change when conditions change.
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms

- Distinguish among directional, disruptive, and stabilizing selection.
- Distinguish among sympatric, parapatric, and allopatric speciation.
- Compare microevolution and macroevolution.



lacking this trait.

- Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline, and sometimes the extinction, of some species.
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.
- Empirical evidence is required to differentiate between cause and correlation and make claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

## Assessment Evidence

### **Suggested Performance Tasks:**

- [Activity: How Could Complex Eyes Have Evolved?](#)
- [Activity: Evolution By Natural Selection](#)
- [Activity: Evolution and Adaptations](#)
- [Activity: The Ecology of Lyme Disease](#)

### **Required District/State Assessments:**

- District marking period assessments
- SGO assessments

### **Suggested Formative/Summative Assessments:**

- Lab/activity report
- Practice Worksheets
- Section Quizzes



- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

## Learning Plan

### **Learning Activities:**

- Class Discussions
- Teacher facilitated inquiry (various inquiry levels)
- Teacher Demonstrations
- Student research for planning lab investigations
- Learning Stations
- Group Collaboration
- In-Class Skill Practice
- The use of various instructional practices tailored to the learning needs of the class (Project Based Instruction, Cooperative Learning, Socratic Questioning, etc.)
- 5E Model Learning Progression (engage, explore, explain, elaborate, evaluate)

## Related Standards

### **Interdisciplinary connections**

- Literary arts
  - ⇒ NJSLA.W9 Draw evidence from informational texts describing common ancestry and biological



evolution.

- Example: Cite specific evidence from text in regards to the process of natural selection and evolution.
- Mathematics
  - ⇒ 7.RP.A.2 Recognize and represent proportional relationships between populations
  - Example: Make sense of quantities and relationships between specific biotic and abiotic differences in ecosystems and their contributions to a change in gene frequency over time that leads to adaptation of populations.

### **21st Century Skills (NJSL Career Readiness, Life Literacies, and Key Skills - Technology Literacy)**

- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).
  - ⇒ Example: Students will organize lab data utilizing Google Sheets. Results will be analyzed utilizing formulas and summarized with the appropriate chart.

### **NJ SEL Competencies**

- Self-Management: Understand and practice strategies for managing one's own emotions, thoughts, and behaviors
- Self-Management: Recognize the skills needed to establish and achieve personal and educational goals

### **Culturally Relevant Connections**

- Provide opportunities for students to connect with people of similar backgrounds (i.e. conversations via digital tools such as Zoom, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (i.e. multiple representation and multimodal experiences).
- Structure the learning around explaining or solving a social or community-based issue.
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

### **Accommodations**



**Special Education/ 504/ At Risk Students**  
**Accommodations & Modifications:**

- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.
- Use project-based science learning to connect science with observable phenomena.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques- auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).

**ELL:**

- Provide multiple literacy strategies
- Use of word/picture walls in the classroom displaying a list of key academic vocabulary words for reference (from a specific unit).
- Provide graphic organizers
- Provide students with visual aids like pictures and diagrams to illustrate the processes of evolution
- Have students work in small groups where they are able to support each other's learning by giving each other input and filling in gaps in background.

**Enrichment**

- Extended learning goals:
  - ⇒ Gizmo: stem case human evolution
  - ⇒ Macroevolution, microevolution, artificial selection, natural selection, traits, alleles, fitness, selective pressures, mutations
  - ⇒ Overview of bacteria and antibiotics, over prescription, use of antibiotics in farming
  - ⇒ Diversity of genes and genetic resistance
  - ⇒ Non-random nature of evolution
  - ⇒ allele frequency, directional, stabilizing, and disruptive selection
  - ⇒ directional, stabilizing and disruptive selection, more detailed exploration of gene flow, genetic drift, founder effect, bottleneck effect

**Unit 5: Ecology / Interdependence**





## Desired Outcomes

### **Established Goals: NJSL**

#### Life Science (LS)

- HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- 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
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity
- HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
- HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

#### Earth and Space Sciences (ESS)

- HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity
- Engineering, Technology, and Applications of Science (ETS)
- HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants
- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts



- HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

**Established Goals:**

1. Illustrate how interactions among living systems and with their environment result in the movement of matter and energy.
2. Graph real or simulated populations and analyze the trends to understand consumption patterns and resource availability, and make predictions as to what will happen to the population in the future
3. Provide evidence that the growth of populations are limited by access to resources, and how selective pressures may reduce the number of organisms or eliminate whole populations of organisms.
4. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
5. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
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.
7. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
8. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
9. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
10. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants
11. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.



12. Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
13. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

<b><i>Science and Engineering Practices</i></b>	<b><i>Disciplinary Core Ideas</i></b>	<b><i>Crosscutting Concepts</i></b>
<b>Using Mathematics and Computational Thinking</b> Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. <ul style="list-style-type: none"><li>• Use mathematical and/or computational representations of phenomena or design</li></ul>	<b>LS2.A: Interdependent Relationships in Ecosystems</b> <ul style="list-style-type: none"><li>• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any</li></ul>	<b>Cause and Effect</b> <ul style="list-style-type: none"><li>• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)</li></ul> <b>Scale, Proportion, and Quantity</b> <ul style="list-style-type: none"><li>• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)</li><li>• Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)</li></ul> <b>Stability and Change</b>

- solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
  - Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
  - Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

### Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Evaluate the claims, evidence,

given ecosystem. (HS-LS2-1),(HS-LS2-2)

### LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6),(HS-LS2-7)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)

### Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4)

### Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-ESS3-3)
- New technologies can have

and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)

### **Constructing Explanations and Designing Solutions**

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (HS-ETS1-2)

climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

### **LS2.D: Social Interactions and Group Behavior**

- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

### **ESS3.C: Human Impacts on Earth Systems**

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

### **ETS1.A: Defining and Delimiting Engineering Problems**

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design

deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

### **Connections to Nature of Science**

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Scientific Knowledge is Open to Revision in Light of New Evidence

- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

### Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6)

### Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and

meets them. (HS-ETS1-1)

- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

### ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one

design problems using models and simulations. <ul style="list-style-type: none"><li>Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)</li></ul>	is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)  <b>ETS1.C: Optimizing the Design Solution</b> <ul style="list-style-type: none"><li>Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)</li></ul>	
<b><u>Enduring Understandings:</u></b> <ul style="list-style-type: none"><li>Energy and matter is transferred through all ecological levels.</li><li>All organisms have complex cellular cycles and processes to produce and store energy.</li><li>Complex processes shape the environment and organisms that are present.</li></ul>	<b><u>Essential Questions:</u></b> <ul style="list-style-type: none"><li>How and why do organisms interact with their environment and what are the effects of these interactions?</li><li>How does biodiversity affect humans?</li><li>How do engineers solve problems?</li><li>How is energy transferred and conserved?</li></ul>	
<b><u>Students will know:</u></b> <ul style="list-style-type: none"><li>Interdependent relationships in ecosystems</li></ul>	<b><u>Students will be able to:</u></b> <ul style="list-style-type: none"><li>Classify the main freshwater and marine biomes</li></ul>	



- Dynamics of ecosystems
- Functioning, resilience, and social interactions
- Carrying capacity
- Factors affecting biodiversity
- Populations
- Cycling of matter and flow through the ecosystem
- Human impact on the environment and solutions to human caused environmental problems

**Concepts:**

- The sustainability of human societies and the biodiversity that supports them require responsible management of natural resources.
- Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change.
- Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on

- Identify the main abiotic factors that impact organisms in aquatic biomes
- Interpret information on how changes in abiotic factors influence species composition and distribution within aquatic ecosystems and communities
- Identify some characteristics of aquatic biomes and some adaptations of the organisms that live in them
- Describe how pollution and other human activities impact aquatic biomes
- Describe how resource extraction impacts aquatic biomes
- Explain how invasive species can impact aquatic biomes
- Identify the factors of population demographics, including size, density, and distribution.
- Distinguish between exponential and logistic growth.
- Define carrying capacity, K.
- Describe a population, a community, and an ecosystem.
- Describe the interactions between organisms that occur in a community.
- Describe the process through which an ecosystem is established.
- Describe the unique characteristics of water communities
- Describe the characteristics of the terrestrial biomes.
- Describe the processes, features, and significance of the water cycle.
- Describe the processes, features, and significance of the carbon cycle.



Earth.

- Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- When evaluating solutions, it is important to take into account a range of constraints—including costs, safety, reliability, and aesthetics—and to consider social, cultural, and environmental impacts.
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of cost and benefits is critical.
- Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.
- Analysis of costs and benefits is a critical aspect of decisions about technology.
- Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support.
- These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce
  - Describe the processes, features, and significance of the nitrogen cycle.
  - Describe the processes, features, and significance of the phosphorus cycle.



populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (the number of individuals) of species in any given ecosystem.

- Quantitative analysis can be used to compare and determine relationships among interdependent factors that affect the carrying capacity of ecosystems at different scales.
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.
- If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem.
- Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

### Assessment Evidence

#### **Suggested Performance Tasks:**

- [Population Growth – Exponential and Logistic Models vs. Complex Realities](#)
- [Changing Biological Communities – Disturbance and Succession](#)
- Carbon Cycle Game Simulation

#### **Required District/State Assessments:**

- District marking period assessments
- SGO assessments

#### **Suggested Formative/Summative Assessments:**



- Food Web Project
- [Population Pyramids](#)
- [Age Structure Diagram](#)
- [Bottle Biology Energy Systems](#)
- Biomes Project

- Lab/activity report
- Practice Worksheets
- Section Quizzes
- Chapter Tests
- Short/extended constructed response items from ELA NJGPA/NJSLA and Science NJSLA
- Projects
- Journals
- Observation
- Graphic organizers/concept mapping
- Presentations
- Warmups / exit tickets

## Learning Plan

### **Learning Activities:**

- Class Discussions
- Teacher facilitated inquiry (various inquiry levels)
- Teacher Demonstrations
- Student research for planning lab investigations
- Learning Stations
- Group Collaboration
- In-Class Skill Practice
- The use of various instructional practices tailored to the learning needs of the class (Project Based Instruction, Cooperative Learning, Socratic Questioning, etc.)
- 5E Model Learning Progression (engage, explore, explain, elaborate, evaluate)



## Related Standards

### **Interdisciplinary connections**

- English Language Arts
  - ⇒ NJSLSA.W9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    - Example: Students will conduct research to determine why bald eagles numbers dropped and were put on the endangered species list and what efforts caused their numbers to increase.
- Mathematics
  - ⇒ S-IC A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
    - Example: Students will interpret population graphs exhibiting exponential and linear growth to determine the carry capacity constraints on ecosystem resources.

### **21st Century Skills (NJSLC Career Readiness, Life Literacies, and Key Skills - Technology Literacy)**

- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
  - ⇒ Example: Students will research and develop a plan on how to lessen the negative effects of an invasive species in New Jersey.

### **NJ SEL Competencies**

- Responsible Decision-Making: Identify the consequences associated with one's actions in order to make constructive choices
- Relationship Skills: Identify ways to resist inappropriate social pressure

## Culturally Relevant Connections

- Everyone has a Voice: Create a classroom environment where students know that their contributions are expected and valued. Example: Students are capable of sharing observations, discussing investigative data, and otherwise contributing to the classroom community. Students learn new ways of looking at problem solving by working with and listening to each other.



- Run Problem Based Learning Scenarios: Encourage scientifically productive discourse among students by presenting problems that are relevant to them, the school or the community. Example: students explore science concepts while determining ways to address problems that are pertinent to them like threatened and endangered species, invasive species, farming and soil erosion.
- There are multiple viewpoints reflected in the content of the lesson/unit.
- The materials and references are reflective of the diverse identities and experiences of the students
- Opportunities are provided for students to reflect on their learning and to provide feedback.

## Accommodations

### **Special Education/ 504/ At Risk Students** **Accommodations & Modifications:**

- Use project-based science learning to connect science with observable phenomena.
- Provide students with multiple choices for how they can represent their understandings (multisensory techniques- auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures.
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understanding.

### **ELL:**

- Provide multiple literacy strategies
- Provide graphic organizers
- Provide students with visual aids like pictures and diagrams to illustrate the processes within an organism's cells.
- Use of word/picture walls in the classroom displaying a list of key academic vocabulary words for reference.
- Have students work in small groups where they are able to support each other's learning by giving each other input and filling in gaps in background.
- Students often work best when they have defined roles that they are responsible for.
- Incorporate writing activities such as science journals to support the acquisition of academic language in science and to empower students with a resource for later reference.

## Enrichment



- Extended learning goals:
  - ⇒ Ecosystems Gizmo STEM Case: As a national park ranger, students must restore the ecosystem of a park back to normal. They interact with populations of many organisms including wolves, deer and bees. Students learn the importance of food chains and webs, and how human factors can impact the health of an environment.
  - ⇒ [Human Population Meter](#): Investigate worldwide past and present trends in human population growth. World Population and top 20 Countries Live Clock. Population in the past, present, and future. Milestones. Global Growth Rate. World population by Region and by Religion. Population Density, Fertility Rate, Median Age, Migrants. All-time population total.

# Appendix A: Culturally Relevant Pedagogy Examples

## BUILDING EQUITY IN YOUR TEACHING PRACTICE

How do the essential questions highlight the connection between the big ideas of the unit and equity in your teaching practice?

CONTENT INTEGRATION	KNOWLEDGE CONSTRUCTION	PREJUDICE REDUCTION	EQUITABLE PEDAGOGY	EMPOWERING SCHOOL CULTURE
Teachers use examples and content from a variety of cultures & groups.	Teachers help students understand how knowledge is created and influenced by cultural assumptions, perspectives & biases.	Teachers implement lessons and activities to assert positive images of ethnic groups & improve intergroup relations.	Teachers modify techniques and methods to facilitate the academic achievement of students from diverse backgrounds.	Using the other four dimensions to create a safe and healthy educational environment for all.
<p>This unit / lesson is connected to other topics explored with students.</p> <p>There are multiple viewpoints reflected in the content of this unit / lesson.</p> <p>The materials and resources are reflective of the diverse identities and experiences of students.</p> <p>The content affirms students, as well as exposes them to experiences other than their own.</p>	<p>This unit / lesson provides context to the history of privilege and oppression.</p> <p>This unit / lesson addresses power relationships.</p> <p>This unit / lesson help students to develop research and critical thinking skills.</p> <p>This curriculum creates windows and mirrors* for students.</p>	<p>This unit / lesson help students question and unpack biases &amp; stereotypes.</p> <p>This unit / lesson help students examine, research and question information and sources.</p> <p>The curriculum encourage discussion and understanding about the groups of people being represented.</p> <p>This unit / lesson challenges dominant perspectives.</p>	<p>The instruction has been modified to meet the needs of each student.</p> <p>Students feel respected and their cultural identities are valued.</p> <p>Additional supports have been provided for students to become successful and independent learners.</p> <p>Opportunities are provided for student to reflect on their learning and provide feedback.</p>	<p>There are opportunities for students to connect with the community.</p> <p>My classroom is welcoming and supportive for all students?</p> <p>I am aware of and sensitive to the needs of my students and their families.</p> <p>There are effective parent communication systems established. Parents can talk to me about issues as they arise in my classroom.</p>

Developed by Karla E. Vigil. Adapted with permission from James A. Banks, CULTURAL DIVERSITY AND EDUCATION: FOUNDATIONS, CURRICULUM, AND TEACHING (6th edition), New York: Routledge, 2016, page 5 and Gordon School Institute on Multicultural Practice.





# Appendix B: English Language Learners

## WIDA Levels:

At the given level of English language proficiency, English language learners will process, understand, produce or use

<b>6- Reaching</b>	<ul style="list-style-type: none"> <li>Specialized or technical language reflective of the content areas at grade level</li> <li>A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse as required by the specified grade level</li> <li>Oral or written communication in English comparable to proficient English peers</li> </ul>
<b>5- Bridging</b>	<ul style="list-style-type: none"> <li>Specialized or technical language of the content areas</li> <li>A variety of sentence lengths of varying linguistic complexity in extended oral or written discourse, including stories, essays or reports</li> <li>Oral or written language approaching comparability to that of proficient English peers when presented with grade level material.</li> </ul>
<b>4- Expanding</b>	<ul style="list-style-type: none"> <li>Specific and some technical language of the content areas</li> <li>A variety of sentence lengths of varying linguistic complexity in oral discourse or multiple, related sentences or paragraphs</li> <li>Oral or written language with minimal phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written connected discourse, with sensory, graphic or interactive support</li> </ul>
<b>3- Developing</b>	<ul style="list-style-type: none"> <li>General and some specific language of the content areas</li> <li>Expanded sentences in oral interaction or written paragraphs</li> <li>Oral or written language with phonological, syntactic or semantic errors that may impede the communication, but retain much of its meaning, when presented with oral or written, narrative or expository descriptions with sensory, graphic or interactive support</li> </ul>
<b>2- Beginning</b>	<ul style="list-style-type: none"> <li>General language related to the content area</li> <li>Phrases or short sentences</li> <li>Oral or written language with phonological, syntactic, or semantic errors that often impede of the communication when presented with one to multiple-step commands, directions, or a series of statements with sensory, graphic or interactive support</li> </ul>
<b>1- Entering</b>	<ul style="list-style-type: none"> <li>Pictorial or graphic representation of the language of the content areas</li> <li>Words, phrases or chunks of language when presented with one-step commands directions, WH-, choice or yes/no questions, or statements with sensory, graphic or interactive support</li> </ul>





## Language Development Supports For English Language Learners To Increase Comprehension and Communication Skills

Environment	
<ul style="list-style-type: none"> <li>• Welcoming and stress-free</li> <li>• Respectful of linguistic and cultural diversity</li> <li>• Honors students' background knowledge</li> <li>• Sets clear and high expectations</li> <li>• Includes routines and norms</li> <li>• Is thinking-focused vs. answer-seeking</li> <li>• Offers multiple modalities to engage in content learning and to demonstrate understanding</li> <li>• Includes explicit instruction of specific language targets</li> <li>• Provides participation techniques to include all learners</li> </ul>	<ul style="list-style-type: none"> <li>• Integrates learning centers and games in a meaningful way</li> <li>• Provides opportunities to practice and refine receptive and productive skills in English as a new language</li> <li>• Integrates meaning and purposeful tasks/activities that:               <ul style="list-style-type: none"> <li>○ Are accessible by all students through multiple entry points</li> <li>○ Are relevant to students' lives and cultural experiences</li> <li>○ Build on prior mathematical learning</li> <li>○ Demonstrate high cognitive demand</li> <li>○ Offer multiple strategies for solutions</li> <li>○ Allow for a language learning experience in addition to content</li> </ul> </li> </ul>

Sensory Supports*	Graphic Supports*	Interactive Supports*	Verbal and Textual Supports
<ul style="list-style-type: none"> <li>• Real-life objects (realia) or concrete objects</li> <li>• Physical models</li> <li>• Manipulatives</li> <li>• Pictures &amp; photographs</li> <li>• Visual representations or models such as diagrams or drawings</li> <li>• Videos &amp; films</li> <li>• Newspapers or magazines</li> <li>• Gestures</li> <li>• Physical movements</li> <li>• Music &amp; songs</li> </ul>	<ul style="list-style-type: none"> <li>• Graphs</li> <li>• Charts</li> <li>• Timelines</li> <li>• Number lines</li> <li>• Graphic organizers</li> <li>• Graphing paper</li> </ul>	<ul style="list-style-type: none"> <li>• In a whole group</li> <li>• In a small group</li> <li>• With a partner such as <i>Turn-and-Talk</i></li> <li>• In pairs as a group (first, two pairs work independently, then they form a group of four)</li> <li>• In triads</li> <li>• Cooperative learning structures such as <i>Think-Pair-Share</i></li> <li>• Interactive websites or software</li> <li>• With a mentor or coach</li> </ul>	<ul style="list-style-type: none"> <li>• Labeling</li> <li>• Students' native language</li> <li>• Modeling</li> <li>• Repetitions</li> <li>• Paraphrasing</li> <li>• Summarizing</li> <li>• Guiding questions</li> <li>• Clarifying questions</li> <li>• Probing questions</li> <li>• Leveled questions such as <i>What? When? Where? How? Why?</i></li> <li>• Questioning prompts &amp; cues</li> <li>• Word Banks</li> <li>• Sentence starters</li> <li>• Sentence frames</li> <li>• Discussion frames</li> <li>• Talk moves, including <i>Wait Time</i></li> </ul>

\*from *Understanding the WIDA English Language Proficiency Standards. A Resource Guide*. 2007 Edition.. Board of Regents of the University of Wisconsin System, on behalf of the WIDA Consortium—[www.wida.us](http://www.wida.us).

*Galina (Halla) Jmourko, ESOL Coach, PGCPs; 2015, Rvsd. 2016*



## Appendix C: WIDA ELD Standards Integration

ELD-SC 9-12 Explain Interpretive	<p>Interpret scientific explanations by</p> <ul style="list-style-type: none"><li>• Defining investigable questions or problems based on observations, information, and/or data about a phenomenon</li><li>• Paraphrasing central ideas in complex evidence, concepts, processes, and information to help explain how or why a phenomenon occurs</li><li>• Evaluating the extent to which reasoning, theory and/or models link evidence to claims and support conclusions</li></ul>
ELD-SC 9-12 Explain Expressive	<p>Construct scientific explanations that</p> <ul style="list-style-type: none"><li>• Describe reliable and valid evidence from multiple sources about a phenomenon</li><li>• Establish neutral or objective stance in how results are communicated</li><li>• Develop reasoning to illustrate and/ or predict the relationships between variables in a system or between components of a system</li><li>• Summarize and refine solutions referencing scientific knowledge, evidence, criteria, and/or trade-offs</li></ul>
ELD-SC.9-12 Argue Interpretive	<p>Interpret scientific arguments by</p> <ul style="list-style-type: none"><li>• Identifying appropriate and sufficient evidence from data, models, and/ or information from investigations of a phenomenon or design solutions</li><li>• Comparing reasoning and claims based on evidence from competing arguments or design solutions</li><li>• Evaluating currently accepted explanations, new evidence, limitations (trade-offs), constraints, and ethical issues</li></ul>
ELD-SC.9-12 Argue Expressive	<p>Construct scientific arguments that</p> <ul style="list-style-type: none"><li>• Introduce and contextualize topic/ phenomenon in current scientific or historical episodes in science</li><li>• Defend or refute a claim based on data and evidence</li><li>• Establish and maintain an appropriate tone and stance (neutral/objective or biased/subjective)</li><li>• Signal logical relationships among reasoning, evidence, data, and/or models when making and defending a claim, counterclaim, and/or rebuttal</li></ul>



## Appendix D: Differentiated Instruction

Strategies to accommodate based on student individual needs::

1. Time/General
  - a. Extra time for assigned tasks
  - b. Adjust length of assignment
  - c. Timeline with due dates for reports and projects
  - d. Communication system between home and school
  - e. Provide lecture notes/outline
2. Processing
  - a. Extra Response time
  - b. Have students verbalize steps
  - c. Repeat, clarify or reword directions
  - d. Mini-breaks between tasks
  - e. Provide a warning for transitions
  - f. Partnering
3. Comprehension
  - a. Precise processes for balanced math instructional model
  - b. Short manageable tasks
  - c. Brief and concrete directions
  - d. Provide immediate feedback
  - e. Small group instruction
  - f. Emphasize multi-sensory learning
4. Recall
  - a. Teacher-made checklist
  - b. Use visual graphic organizers
  - c. Reference resources to promote independence
  - d. Visual and verbal reminders
  - e. Graphic organizers
5. Assistive Technology
  - a. Computer/whiteboard
  - b. Tape recorder
  - c. Video Tape
6. Tests/Quizzes/Grading
  - a. Extended time
  - b. Study guides
  - c. Shortened tests
  - d. Read directions aloud
7. Behavior/Attention
  - a. Consistent daily structured routine
  - b. Simple and clear classroom rules
  - c. Frequent feedback
8. Organization
  - a. Individual daily planner
  - b. Display a written agenda
  - c. Note-taking assistance
  - d. Color code materials



## Appendix E: Enrichment

What is the purpose of enrichment?

The purpose of enrichment is to provide extended learning opportunities and challenges to students who have already mastered, or can quickly master, the basic curriculum. Enrichment gives the student more time to study concepts with greater depth, breadth, and complexity.

- Enrichment also provides opportunities for students to pursue learning in their own areas of interest and strengths.
- Enrichment keeps advanced students engaged and supports their accelerated academic needs.
- Enrichment provides the most appropriate answer to the question, “What do you do when the student already knows it?”

Enrichment is ...	Enrichment is not...
<ul style="list-style-type: none"><li>• Planned and purposeful</li><li>• Different, or differentiated, work – not just more work</li><li>• Responsive to students’ needs and situations</li><li>• A promotion of high-level thinking skills and making connections within content</li><li>• The ability to apply different or multiple strategies to the content</li><li>• The ability to synthesize concepts and make real world and cross curricular connections</li><li>• Elevated contextual complexity</li><li>• Sometimes independent activities, sometimes direct instruction</li><li>• Inquiry based or open-ended assignments and projects</li><li>• Using supplementary materials in addition to the normal range of resources</li><li>• Choices for students</li><li>• Tiered/Multi-level activities with flexible groups (may change daily or weekly)</li></ul>	<ul style="list-style-type: none"><li>• Just for gifted students (some gifted students may need intervention in some areas just as some other students may need frequent enrichment)</li><li>• Worksheets that are more of the same (busywork)</li><li>• Random assignments, games, or puzzles not connected to the content areas or areas of student interest</li><li>• Extra homework</li><li>• A package that is the same for everyone</li><li>• Thinking skills taught in isolation</li><li>• Unstructured free time</li></ul>



# Appendix F: Resources

**Textbook:** Biology (Pearson/ Prentice Hall, 2008 and 2018, Miller & Levine)



## Appendix G: Climate Change Curriculum Statement

With the adoption of the 2020 New Jersey Student Learning Standards (NJSLS), New Jersey became the first state in the nation to include climate change across content areas. These standards are designed to prepare students to understand how and why climate change happens, the impact it has on our local and global communities and to act in informed and sustainable ways.

Districts are encouraged to utilize the NJSLS to develop interdisciplinary units focused on climate change that include authentic learning experiences, integrate a range of perspectives and are action oriented. While the 2016 NJSLS-English Language Arts (ELA) and Mathematics do not have specific climate change standards, districts may want to consider how they can design interdisciplinary climate change units that incorporate relevant ELA and mathematics standards.

Components of this are tagged throughout the curriculum as appropriate under the “Related Standards” section in each unit.