Biology

Length of Course: Term
Elective/Required: Required
Schools: High School
Eligibility: Grade 9, 10
Credit Value: 6 Credits
Date Approved: August 26, 2019
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of Purpose</td>
<td>3</td>
</tr>
<tr>
<td>Course Objectives</td>
<td>4</td>
</tr>
<tr>
<td>Time Line</td>
<td>7</td>
</tr>
<tr>
<td>Unit 1: Structure and Function</td>
<td>11</td>
</tr>
<tr>
<td>Unit 2: Cellular Specialization</td>
<td>18</td>
</tr>
<tr>
<td>Unit 3: Cell Reproduction and Inheritance</td>
<td>29</td>
</tr>
<tr>
<td>Unit 4: Evolution and Ecosystems</td>
<td>36</td>
</tr>
</tbody>
</table>
Statement of Purpose

Biology is offered to ninth and tenth graders as part of a sequence of college preparatory, laboratory science courses. It is preceded in that sequence by Environmental Science and, traditionally, followed by Chemistry and Physics. The course presents a comprehensive survey of the life sciences at a level appropriate to its intended audience. The course content is based on the most current New Jersey Core Curriculum Content Standards for science, including science practices. In addition, it connects the subject matter to everyday experiences, life science careers and environmental concerns. The Career Ready and Educational Technology Standards are embedded in the curriculum.

This curriculum guide was compiled in the year of 2015 and revised in 2016 and in 2018 and 2019 it was designed to follow NGSS/NJSLS and utilize existing course materials, Discovery Education Science TechBook, Miller & Levine Biology (Pearson 2019), Biology Concepts and Applications (Cengage 2018), and Gizmos (www.explorelearning.com).

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Course Objectives

By the end of the Biology course, students will be able to:

- **(NJSLS/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. (Quarter 2)
- **(NJSLS/HS-LS1-2)** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (Quarter 1)
- **(NJSLS/HS-LS1-3)** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (Quarter 1)
- **(NJSLS/HS-LS1-4)** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (Quarter 3)
- **(NJSLS/HS-LS1-5)** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (Quarter 2)
- **(NJSLS/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. (Quarter 1)
- **(NJSLS/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. (Quarter 2)
- **(NJSLS/HS-LS2-1)** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (Quarter 4)
- **(NJSLS/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. (Quarter 4)
- **(NJSLS/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. (Quarters 2 and 4)
- **(NJSLS/HS-LS2-4)** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (Quarters 2 and 4)
- **(NJSLS/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. (Quarters 2 and 4)
- **(NJSLS/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. (Quarter 4)
Course Objectives (cont.)

- **(NJSLS/HS-LS2-7)** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Quarter 4)
- **(NJSLS/HS-LS2-8)** Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. (Quarter 4)
- **(NJSLS/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. (Quarters 2, 3)
- **(NJSLS/HS-LS3-2)** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (Quarter 2, 3)
- **(NJSLS/HS-LS3-3)** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. (Quarters 3, 4)
- **(NJSLS/HS-LS4-1)** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (Quarter 4)
- **(NJSLS/HS-LS4-2)** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (Quarter 4)
- **(NJSLS/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. (Quarter 4)
- **(NJSLS/HS-LS4-4)** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (Quarter 4)
- **(NJSLS/HS-LS4-5)** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (Quarter 4)
- **(NJSLS/HS-LS4-6)** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Quarter 4)
- **(NJSLS/HS-ESS2-5)** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (Quarter 1)
- **(NJSLS/HS-ESS2-6)** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (Quarter 2)
- **(NJSLS/HS-ESS2-7)** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (Quarter 4)
- **(NJSLS/HS-ESS3-1)** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. (Quarter 4)
Course Objectives (cont.)

- **(NJSLS/HS-ESS3-3)** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. (Quarter 4)
- **(NJSLS/HS-ESS3-4)** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (Quarter 4)
- **(NJSLS/HS-ESS3-5)** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. (Quarter 4)
- **(NJSLS/HS-ESS3-6)** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. (Quarter 4)

**Engineering Design**

- **(NJSLS/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.
- **(NJSLS/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.
- **(NJSLS/HS-ETS1-3)** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- **NJSLS/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
First Quarter Units - Unit 1: Structure and Function

- Characteristics of Living Things
  - Emergent properties
  - Hierarchy within organisms
  - Properties of water, as relating to organisms

- Macromolecules
  - Carbohydrates
  - Lipids
  - Proteins / Enzymes
  - Nucleic Acids

- Homeostasis
  - Positive / Negative feedback and examples
  - pH

- Membrane Transport
  - Passive and Active Transport
  - Osmosis

*Topics may not be covered equally on the quarterlies*
Second Quarter Units - Unit 2: Cell Specialization

- Cycling of Carbon between living things
  - Photosynthesis
  - Cellular Respiration
    - Aerobic respiration
    - Anaerobic respiration

- Central Dogma
  - DNA structure and replication
  - Protein Synthesis
  - Gene expression
  - Mutations

*Topics may not be covered equally on the quarterlies*
Third Quarter Units- Unit 3: Cellular Reproduction and Inheritance

- Life cycle
  - Cell Cycle
    - Control of cycle
    - Mitosis
    - Apoptosis, cancer and tumors
    - Differentiation
  - Meiosis
    - Ploidy
    - Genetic recombination
      - Independent assortment
      - Crossing over
    - Chromosomal mutations and nondisjunction
    - Karyotypes
  - Fertilization

- Genetics
  - Mendelian genetics
  - Nonmendelian genetics
    - Sex-linkage
    - Codominance / Blood types
    - Incomplete dominance
  - Pedigrees
  - Gene Technology

*Topics may not be covered equally on the quarterlies*
Fourth Quarter Units - Unit 4: Evolution and Ecology

- Evolution
  - Evidence of Evolution
  - Microevolution
    - Natural selection
    - Artificial selection
    - Sexual selection
    - Antibiotic and pesticide resistance
    - Genetic drift
      - Bottleneck effect
      - Founder effect
      - Mutation
    - Gene flow
    - Hardy Weinberg (Honors and level 1)
  - Macroevolution
    - Speciation
    - Emergence of new species as a result of extinction
    - Reproductive barriers
    - Group behavior
    - Phylogenetic trees / Cladogram

- Ecology
  - Biogeochemical cycles (Carbon, nitrogen, water)
  - Energy Transformations
    - Food webs
    - Energy pyramids
  - Population Ecology
    - Carrying capacity
    - Density dependent/independent factors
    - Succession
  - Biodiversity
  - Evaluate a solution to mitigate the effect of human activity on:
    - Climate
    - Changing biodiversity
    - Natural systems

*Topics may not be covered equally on the quarterlies*
Unit 1: Structure and Function

**Essential Questions:** Phenomena: Homeostasis and Metabolic Disorders
- How do the structures of molecules enable life’s functions?
- How are life’s functions adjusted as a result of molecules (Homeostasis)?

**NGSS Performance Expectations:** (Students who demonstrate understanding can:)
- NJSLS/HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms
- NJSLS/HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- NJSLS/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.
- NJSLS/HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

**Unit Assessment:** (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
- Quarterly Exam
- Disruption of Homeostasis- Students will research and conduct experiments to study the effect of changes in the environment or cell structures on the response of an organism. Examples may include heart rate response to exercise, stomate response to moisture and temperature, root development in response to water levels, or research metabolic disorders.

**Resources:**

**Discovery Education Science TechBook: Biology**
- The Chemistry of Living Things
  - Atoms, Elements, Compounds, and Chemical Bonds
  - Water
  - Chemical Reactions
  - Acids and Bases
- The Chemistry of Life
- Cells
- Cell Structure and Function
- Animals
- Homeostasis

**Miller & Levine Biology**
- 2.1 The Nature of Matter pg. 42-46
- 2.2 Properties of Water pg.47-51
- 2.3 Carbon Compounds pg. 52-57
- 2.4 Chemical Reactions and Enzymes pg. 58-61
- 3.1 Levels of Ecological Organization (Fig. 3-1) pg. 79
- 8.1 Prokaryotes and Eukaryotes pg. 246-247
- 8.2 Cellular Boundaries pg. 256-257
- 8.3 Cell Transport pg. 260-265
- 8.4 Homeostasis and Cells pg. 266-269
**Cengage Biology Concepts and Applications**

- 1.1 - Life is More Than the Sum of its Parts pg. 4-5
- 2.1 - Building Blocks of Matter pg. 24-25
- 2.2 - Why Electrons Matter pg. 26-27
- 2.3 - From Atoms to Molecules pg. 28-29
- 2.4 - Hydrogen Bonds and Water pg. 30-31
- 2.5 - Acids and Bases pg. 32-34
- 3.1 - The Chemistry of Biology pg. 38-39
- 3.2 - Carbohydrates pg. 40-41
- 3.3 - Lipids pg. 42-43
- 3.4 - Proteins pg. 44-45
- 3.5 - The Importance of Protein Structure pg. 46
- 3.6 - Nucleic Acids pg. 47
- 4.3 - Cell Membrane and Structure pg. 56-57
- 5.6 - Diffusion and Membranes pg. 88-89
- 5.7 - Membrane Transport Mechanisms pg. 90-91
- 5.8 - Membrane Trafficking pg. 92-93
- 28.8 - Negative Feedback in Homeostasis pg. 494-495
- 31.1 - Feedback Loops pg. 538-548

**Other Activities**

- Characteristics of Living Things
  - Identify /diagram nested levels of hierarchical structural organization and apply those diagrams to specific human systems
  - Properties of Water activity
- Macromolecules
  - Test foods for macromolecules
  - Building blocks for macromolecules activity
  - Enzyme lab
- Homeostasis
  - Diagram/analyze feedback loops
  - Homeostasis/Organism response investigation (can be done as unit assessment)
  - pH activity
- Membrane Transport
  - Osmosis lab

**Suggested Gizmos**

- Cell Types
- Circulatory System
- Dehydration Synthesis
- Digestive System
- Enzymes- STEM case
- Homeostasis
- Human Homeostasis
- Paramecium Homeostasis
- Senses
Biology

Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- Miller & Levine Biology
- Cengage Biology Concepts and Applications
- For phenomena ideas: www.NGSSPhenomena.com
- For simulation labs: https://concord.org/stem-resources/subject/biology
- For readings, quizzes, and simulations: www.ck12.org

ELA/ Literacy

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using 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. (HS-LS1-3)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-ESS2-5)

Math

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-5)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.

8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.

8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

8.1.12.D.1 Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.

Career Ready Practices

CRP1. Act as a responsible and contributing citizen and employee.

CRP2. Apply appropriate academic and technical skills.

CRP3. Attend to personal health and financial well-being.

CRP4. Communicate clearly and effectively and with reason.

CRP5. Consider the environmental, social and economic impacts of decisions.

CRP6. Demonstrate creativity and innovation.

CRP7. Employ valid and reliable research strategies.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

CRP9. Model integrity, ethical leadership and effective management.

CRP10. Plan education and career paths aligned to personal goals.

CRP11. Use technology to enhance productivity.

CRP12. Work productively in teams while using cultural global competence.
### Unit 1: Structure and Function (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Instructional Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLH/HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms</td>
<td>Activities/Strategies: Technology Implementation/Interdisciplinary Connections</td>
</tr>
</tbody>
</table>

#### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Activities/Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LS1.A: Structure and Function</strong></td>
<td>Develop 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</td>
<td>System 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.</td>
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<tr>
<td>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.</td>
<td>Identify/diagram nested levels of hierarchical structural organization</td>
<td>Apply those diagrams to specific human systems</td>
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<tr>
<td>Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.</td>
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<td>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</td>
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</tbody>
</table>

#### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.

**Assessment Boundary:** Assessment does not include interactions and functions at the molecular or chemical reaction level. This objective will also be met in Unit 2, where transcription and translation will be discussed in further detail.
## Unit 1: Structure and Function (cont.)

**Student Learning Objectives:** (SLO)
NJSLS/HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Instructional Actions</th>
<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>Planning and carrying out investigations 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.</td>
<td>Feedback (negative or positive) can stabilize or destabilize a system.</td>
<td>Diagram/analyze feedback loops Enzyme lab Homeostasis/Organism response investigation (can be done as unit assessment)</td>
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</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water loss.

**Assessment Boundary:** Assessment does not include the cellular processes involved in the feedback mechanism
# Unit 1: Structure and Function (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
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</thead>
<tbody>
<tr>
<td>NJSLH/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.</td>
<td><strong>Crosscutting Concepts</strong></td>
</tr>
<tr>
<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Science and Engineering Practices</strong></td>
</tr>
</tbody>
</table>
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 form new cells.  
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. | 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. | Energy and Matter  
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. |
|  |  | Building blocks for macromolecules activity  
Test foods for macromolecules |
| Instructional Adjustments: Modifications, student difficulties, possible misunderstandings |  | Tests  
Quizzes  
Formative Assessments  
Labs/Activities  
Homework |
| Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations. |  |  |
| Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules. |  |  |
### Unit 1: Structure and Function (cont.)

**Student Learning Objectives:** (SLO)

**NJSLHS/HS-ESS2.5:** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Instructional Actions</th>
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<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESS2.C: The Roles of Water in Earth's Surface Processes</strong></td>
<td>Planning and Carrying Out Investigations</td>
<td>Structure and Function</td>
<td>Technology Implementation/ Interdisciplinary Connections</td>
<td>Properties of Water activity</td>
<td>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</td>
</tr>
<tr>
<td>The abundance of liquid water on Earth’s surface and its unique combination of physical and chemical properties are central to the planet’s dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks</td>
<td>Planning and carrying out investigations 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.</td>
<td>The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substrutures of its various materials.</td>
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</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on using evidence from models and simulations to support explanations.

**Assessment Boundary:** Assessment does not include the details of the specific chemical reactions or identification of macromolecules.
Unit 2: Cell Specialization

**Essential Questions:** Overarching Phenomena of interest: Cells meet the demands of organisms

- How do the structures of cells enable life's functions?
- How does information coded in DNA result in proteins?

**NGSS Performance Expectations:** (Students who demonstrate understanding can:)

- NJSL/H-S-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.
- NJSL/H-S-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- NJSL/H-S-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.
- NJSL/H-S-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- NJSL/H-S-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.
- NJSL/H-S-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.
- NJSL/H-S-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

**Unit Assessment:** (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)

- Quarterly Exam
- Design an experiment to test the effect of a variable on cellular respiration or photosynthesis, including mathematical representations

**Resources:**

**Discovery Education Science TechBook: Biology**

- Energy and Life
  - Photosynthesis
  - Cellular Respiration
  - Energy for Life
- Cells
  - Cell Structure and Function
  - Cell Division
  - Cell Transport
  - Asexual and Sexual Reproduction

- Heredity
  - Genetics
  - DNA
  - Transcription and Translation
  - Cause and Effect of Mutations
  - Genetic Disorders and Technology
  - Genetic Technology
Biology

**Miller & Levine Biology**

- Cycling of Carbon Between Living Things
  - 9.1 Energy and Life pg. 282-285
  - 9.2 Photosynthesis: An Overview pg. 286-290
  - 9.3 The Process of Photosynthesis (Level 1 only) pg. 291-297
  - 10.1 Cellular Respiration: An overview pg. 310-313
  - 10.2 The Process of Cellular Respiration (Level 1 only) pg. 314-320
  - 10.3 Fermentation pg. 321-323

- Central Dogma
  - 13.1 Identifying the Substance of the Gene pg. 412-417
  - 13.2 The Structure of DNA pg. 418-423
  - 13.3 DNA Replication pg. 424-427
  - 14.1 RNA pg. 440-444
  - 14.2 Ribosomes and Protein Synthesis pg. 445-450
  - 14.3 Eukaryotic Gene Regulation pg. 453
  - 14.3 Epigenetics pg. 455
  - 14.3 Environmental Influences pg. 456
  - 14.4 Mutations pg. 457-461

- Cengage Biology Concepts and Applications

  - Cycling of Carbon Between Living Things
    - 4.5- Introducing the Eukaryotic Cell pg. 60-61
    - 4.6- The Endomembrane System pg. 62-63
    - 6.1- Overview of Photosynthesis pg. 100-101
    - 6.2- Sunlight as an Energy Source pg. 102-103
    - 6.3- Light-Dependent Reactions pg. 104-105
    - 6.4- Light-Independent Reaction pg. 106-107
    - 6.5- Carbon-Fixing Adaptations of Plants pg. 108-109
    - 7.1- Introduction to Carbohydrate Breakdown Pathways pg. 114-115
    - 7.2- Glycolysis- Sugar Breakdown Begins pg. 116-117
    - 7.3- Acetyl-CoA Formation and the Citric Acid Cycle pg. 118-119
    - 7.4- Aerobic Respiration’s Big Energy Payoff pg. 120-121
    - 7.5- Fermentation Pathways pg. 122-123
    - 7.6- Food as a Source of Energy pg. 124-127

  - Central Dogma
    - 8.1- The Discovery of DNA’s Function pg. 132-133
    - 8.2- Discovery of DNA’s structure pg. 134-135
    - 8.3- Eukaryotic Chromosomes pg. 136-137
    - 8.4- How Does a Cell Copy Its DNA pg. 138-139
    - 8.5- Mutations and Their Causes pg. 140-141
    - 8.6- Cloning Adult Animals pg. 142-142
    - 9.1- Introducing Gene Expression pg. 148-149
    - 9.2- Transcription: DNA to RNA pg. 150-151
    - 9.3- RNA and the Genetic Code pg. 152-153
    - 9.4- Translation: RNA to Protein pg. 154-155
    - 9.5- Consequences of Mutations pg. 156-157
    - 10.1- How Cells Control Gene Expression pg. 164-165
    - 10.4- Gene Expression in Metabolic Control pg. 170-171
    - 10.5- Epigenetics pg. 172-173

- Other Activities

  - Cycling of Carbon Between Living Things:
    - Photosynthesis activity and/or lab (can be used for unit assessment)
    - Diagram or physical representation (ball and stick) to show the movement of carbons in photosynthesis (Level 1 and Honors)
    - Respiration activity and/or lab (can be used for unit assessment)
    - Diagram or physical representation (ball and stick) to show the movement of carbons in respiration (Honors and level 1)
    - Aerobic vs. Anaerobic respiration comparison
    - Model the carbon cycle- limited to photosynthesis and respiration
    - Compare/ contrast and relate photosynthesis and respiration

  - Central Dogma
    - Modeling of transcription/ translation
    - Protein Synthesis activity
    - Gene Expression Activity - Honors Level Only (for example difference between prokaryotic gene expression and eukaryotic gene expression)
Suggested Gizmos

- Cycling of Carbon Between Living Things
  - Carbon Cycle
  - Cell Energy Cycle
  - Cell Respiration - STEM case
  - Photosynthesis Lab
  - Photosynthesis - STEM case
  - Plants and Snails

- Central Dogma
  - Building DNA
  - RNA and Protein Synthesis

Essential Materials, Supplementary Materials, Links to Best Practices

- Discovery Education Science Tech Book
- Miller & Levine Biology
- Cengage Biology Concepts and Applications
- For phenomena ideas: www.NGSSPhenomena.com
- For simulation labs: https://concord.org/stem-resources/subject/biology
- For readings, quizzes, and simulations: www.ck12.org

ELA/ Literacy

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS -LS1-1)
RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)
SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-5),(HS-LS1-7)

Math

MP.2 Reason abstractly and quantitatively. (HS-ESS2-6)
MP.4 Model with mathematics. (HS-ESS2-6)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-ESS2-6)
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-6)
Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-6)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
8.1.12.D.1 Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.
**Career Ready Practices**

CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP3. Attend to personal health and financial well-being.
CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP10. Plan education and career paths aligned to personal goals.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.
**Unit 2: Cell Specialization (cont.)**

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Instructional Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLS/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.</td>
<td>Activities/Strategies&lt;br&gt;Technology Implementation/&lt;br&gt;Interdisciplinary Connections</td>
</tr>
<tr>
<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Science and Engineering Practices</strong></td>
</tr>
<tr>
<td>LS1.A: Structure and Function</td>
<td>Constructing Explanations and Designing Solutions</td>
</tr>
<tr>
<td>Systems of specialized cells within organisms help them perform the essential functions of life.</td>
<td>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.</td>
</tr>
<tr>
<td>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 most of the work of cells. (Note: This Disciplinary Core Idea is also addressed by NJSLS/HS-LS3-1.)</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Clarification Statement:** Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.

**Assessment Boundary:** Assessment does not include interactions and functions at the molecular or chemical reaction level.
### Unit 2: Cell Specialization (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Instructional Adjustments: Modifications, student difficulties, possible misunderstandings</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLS/HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</td>
<td><strong>Clarification Statement:</strong> Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.</td>
</tr>
<tr>
<td><strong>Instructional Actions</strong></td>
<td><strong>Assessment Boundary:</strong> Assessment does not include specific biochemical steps.</td>
</tr>
<tr>
<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Activities/Strategies</strong> Technology Implementation/Interdisciplinary Connections</td>
</tr>
<tr>
<td><strong>LS1.C: Organization for Matter and Energy Flow in Organisms</strong></td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (NJSLS/HS-LS1-5)</td>
<td>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.</td>
</tr>
<tr>
<td>Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NJSLS/HS-LS1-5)</td>
<td>Energy and Matter 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.</td>
</tr>
<tr>
<td></td>
<td>Diagram or physical representation (ball and stick) to show the movement of carbons in photosynthesis (Level 1 and Honors)</td>
</tr>
<tr>
<td><strong>Crosscutting Concepts</strong></td>
<td>Photosynthesis activity and/or lab (can be used for unit assessment)</td>
</tr>
<tr>
<td><strong>Science and Engineering Practices</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Unit 2: Cell Specialization (cont.)

### Student Learning Objectives: (SLO)
NJSLS/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.

### Disciplinary Core Ideas
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (NJSLS/HS-LS1-6), (NJSLS/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. (NJSLS/HS-LS1-7)

### Science and Engineering Practices
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.

Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NJSLS/HS-LS1-5), (NJSLS/HS-LS1-7)

### Crosscutting Concepts
#### Energy and Matter
Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (NJSLS/HS-LS1-7), (NJSLS/HS-LS2-4)

### Instructional Actions

<table>
<thead>
<tr>
<th>Activities/Strategies</th>
<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Implementation/Interdisciplinary Connections</td>
<td>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</td>
</tr>
<tr>
<td>Respiration activity and/or lab (can be used for unit assessment)</td>
<td></td>
</tr>
<tr>
<td>Diagram or physical representation (ball and stick) to show the movement of carbons in respiration (Honors and level 1)</td>
<td></td>
</tr>
</tbody>
</table>

### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

### Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.

### Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.
### Unit 2: Cell Specialization (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Instructional Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLS/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.</td>
<td>Instructional Adjustments: Modifications, student difficulties, possible misunderstandings</td>
</tr>
<tr>
<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Science and Engineering Practices</strong></td>
</tr>
<tr>
<td>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</td>
<td>Constructing Explanations and Designing Solutions</td>
</tr>
<tr>
<td>Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (NJSLS/HS-LS2-3)</td>
<td>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. (NJSLS/HS-LS1-6),(NJSLS/HS-LS2-3)</td>
</tr>
<tr>
<td><strong>Scientific Knowledge is Open to Revision in Light of New Evidence</strong></td>
<td>Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (NJSLS/HS-LS2-3)</td>
</tr>
</tbody>
</table>

**Clarification Statement:** Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. **Assessment Boundary:** Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.
# Unit 2: Cell Specialization (cont.)

## Student Learning Objectives: (SLO)

**NJSL/S-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. (Focus on process of photosynthesis and respiration in cycling of carbon. Will be revisited in marking period 4)

## Disciplinary Core Ideas | Science and Engineering Practices | Crosscutting Concepts | Instructional Actions | Activities/Strategies | Assessment Check Points
--- | --- | --- | --- | --- | ---
**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**

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. (NJSL/S-HS-LS2-5)

**PS3.D: Energy in Chemical Processes**

The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to NJSL/S-HS-LS2-5)*

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

### 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. (NJSL/S-HS-LS2-5)

- Model the carbon cycle-limited to photosynthesis and respiration

- Compare/contrast and relate photosynthesis and respiration

## Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

## Clarification Statement: Examples of models could include simulations and mathematical models.

## Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.
## Unit 2: Cell Specialization (cont.)

### Student Learning Objectives: (SLO)

NJSLS/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.

### Disciplinary Core Ideas

#### LS1.A: Structure and Function

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. (secondary) (Note: This Disciplinary Core Idea is also addressed by NJSLS/HS-LS1-1.)

#### 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.

### Science and Engineering Practices

#### 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 design problems using models and simulations.

### Crosscutting Concepts

#### Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Instructional Actions

- **Activities/Strategies**
  - Technology Implementation/Interdisciplinary Connections
  - Protein Synthesis activity
  - Gene Expression Activity - Honors Level Only (for example difference between prokaryotic gene expression and eukaryotic gene expression)

### Assessment Check Points

- Tests
- Quizzes
- Formative Assessments
- Labs/Activities
- Homework

### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.
### Unit 2: Cell Specialization (cont.)

#### Student Learning Objectives: (SLO)
NJSL/H5-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from:
1. (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. Will be revisited in marking period 3. Focus is on errors in replication and mutations caused by environmental factors.

<table>
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<tr>
<td><strong>LS3.B: Variation of Traits</strong></td>
<td><strong>Engaging in Arguments from Evidence</strong></td>
<td><strong>Cause and Effect</strong></td>
<td><strong>Technology Implementation/Interdisciplinary Connections</strong></td>
<td><strong>Tests</strong></td>
</tr>
<tr>
<td>In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.</td>
<td>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. Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
<td><strong>Quizzes</strong></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
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<td><strong>Formative Assessments</strong></td>
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<td></td>
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<td><strong>Labs/Activities</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Instructional Adjustments**: Modifications, student difficulties, possible misunderstandings

**Clarification Statement**: Emphasis is on using data to support arguments for the way variation occurs.

**Assessment Boundary**: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.
Unit 3: Cellular Reproduction and Inheritance

Essential Questions: Overarching Phenomenon of Interest: Heredity
- How are the characteristics from one generation related to the previous generation?
- How does genetic information result in physical characteristics

NGSS Performance Expectations: (Students who demonstrate understanding can:)
- NJSL/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.
- NJSL/HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- NJSL/HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- NJSL/HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
- Quarterly Exam
- Students will research a genetic disorder/trait or prepare a model of how genes are inherited over several generations

Resources:
Discovery Education Science TechBook: Biology
- Heredity
  - Genetics
  - DNA
  - Transcription and Translation
  - Cause and Effects of Mutations
  - Genetic Disorders and Technology
  - Genetic Technology
- Cells
  - Cell Structure and Function
  - Cell Division
  - Asexual and Sexual Reproduction

Miller & Levine Biology
- 11.1 Cell Division and Reproduction pg. 341-342
- 11.2 The Process of Cell Division pg. 343-349
- 11.3 Regulating the Cell Cycle pg. 350-354
- 11.4 Cell Differentiation pg. 355-361
- 12.1 The Work of Gregor Mendel pg. 378-382
- 12.2 Applying Mendel’s Principles pg. 383-388
- 12.3 Other Patterns of Inheritance pg. 389-392
- 12.4 Meiosis pg. 393-399
- 15.1 Human Chromosomes pg. 474-479
- 15.2 Human Genetic Disorders pg. 480-484
- 15.3 Studying the Human Genome pg. 485-493
- 16.1 Changing the Living World pg. 506-508
- 16.2 The Process of Genetic Engineering pg. 509-515
- 16.3 Applications of Biotechnology pg. 516-523
- 16.4 Ethics and Impacts of Biotechnology pg. 524-527
Cengage Biology Concepts and Applications

- 11.1 - Multiplication by Division pg. 178-180
- 11.2 - A Closer Look at Mitosis pg. 181
- 11.3 - Cytoplasmic Division pg. 182
- 11.4 - Marking Time With Telomeres pg. 183
- 11.5 - Pathological Mitosis pg. 184-187
- 12.1 - Why Sex? Pg. 192-193
- 12.2 - Meiosis in Sexual Reproduction pg. 194-195
- 12.3 - A Visual Tour of Meiosis pg. 196-197
- 12.4 - How Meiosis Introduces Variation in Traits pg. 198-199
- 12.5 - Mitosis and Meiosis-An Ancestral Connection? Pg. 200-201
- 13.1 - Mendel, Pea Plants and Inheritance Patterns pg. 206-207
- 13.2 - Mendel's Law of Segregation pg. 208-209
- 13.3 - Mendel's Law of Independent Assortment pg. 210-211
- 13.4 - Beyond Simple Dominance pg. 212-213
- 13.5 - Nature and Nurture pg. 214-215
- 13.6 - Complex Variation in Traits pg. 216-217
- 14.1 - Human Chromosomes pg. 222-223
- 14.2 - Examples of Autosomal Inheritance Patterns pg. 224-225
- 14.3 - Examples of X-Linked Inheritance Patterns pg. 226-227
- 14.4 - Changes in Chromosome Structure pg. 228-229
- 14.5 - Changes in Chromosome Number pg. 230-231
- 15.1 - Cutting and Pasting DNA pg. 238-239
- 15.2 - Isolating Genes pg. 240-241
- 15.3 - DNA Sequencing pg. 242-243
- 15.4 - Genomics pg. 244-245
- 15.5 - Genetic Engineering pg. 246-247
- 15.6 - Editing Genomes pg. 248-249

Other Activities
- Life Cycle
  - Mitosis modeling
  - Karyotype activity
- Genetics
  - Punnett Square problems and activities
  - Human genetics lab activity

Suggested Gizmos
- Cell Division
- Chicken Genetics
- DNA Analysis
- Embryo Development
- Fast Plants® 1- Growth and Genetics
- Fast Plants® 2- Mystery Parent
- Genetic Engineering
- GMOs and the Environment
- Human Karyotyping
- Meiosis
- Meowsis- STEM case
- Mouse Genetics (One Trait)
- Mouse Genetics (Two Traits)

Essential Materials, Supplementary Materials, Links to Best Practices
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- Miller & Levine Biology
- Cengage Biology Concepts and Applications
- For phenomena ideas: www.NGSS Phenomena.com
- For simulation labs: https://concord.org/stem-resources/subject/biology
- For readings, quizzes, and simulations: www.ck12.org
### ELA/ Literacy

RST .11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS3-1),(HS-LS3-2)

RST .11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-LS3-1)

WHST .9-12.1 Write arguments focused on discipline-specific content. (HS-LS3-2)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-4)

### Math

MP.2 Reason abstractly and quantitatively. (HS -LS3-2),(HS-LS3-3)

### Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.

8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.

8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

8.2.12.B.3 Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs.

8.1.12.D.1 Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.

### Career Ready Practices

CRP1. Act as a responsible and contributing citizen and employee.

CRP2. Apply appropriate academic and technical skills.

CRP3. Attend to personal health and financial well-being.

CRP4. Communicate clearly and effectively and with reason.

CRP5. Consider the environmental, social and economic impacts of decisions.

CRP6. Demonstrate creativity and innovation.

CRP7. Employ valid and reliable research strategies.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

CRP9. Model integrity, ethical leadership and effective management.

CRP10. Plan education and career paths aligned to personal goals.

CRP11. Use technology to enhance productivity.

CRP12. Work productively in teams while using cultural global competence.
### Unit 3: Cellular Reproduction and Inheritance (cont.)

**Student Learning Objectives:** (SLO)

NJSLS/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.

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<td><strong>LS1.A: Structure and Function</strong></td>
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<td>Cause and Effect</td>
<td>Activities/Strategies Technology Implementation/ Interdisciplinary Connections</td>
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<tr>
<td>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. (secondary) (Note: This Disciplinary Core Idea is also addressed by NJSLS/HS-LS1-1.)</td>
<td>Asking questions and defining 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.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
<td>Punnett square problems and activities</td>
</tr>
<tr>
<td><strong>LS3.A: Inheritance of Traits</strong></td>
<td>Ask questions that arise from examining models or a theory to clarify relationships.</td>
<td></td>
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</tr>
<tr>
<td>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.</td>
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</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Assessment Boundary:** Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.
### Unit 3: Cellular Reproduction and Inheritance (cont.)

**Student Learning Objectives:** (SLO)

NJSLHS/HS-LS3-2 Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Revisited from marking period 2. Focus will be on genetic combinations through meiosis.

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Activities/Strategies Technology Implementation/Interdisciplinary Connections</th>
<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LS3.B: Variation of Traits</strong></td>
<td>Engaging in Arguments from Evidence</td>
<td>Cause and Effect</td>
<td>Cause and effect of mutations Human Genetics activity</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td>In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. 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 occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.</td>
<td>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. Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
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</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on using data to support arguments for the way variation occurs.

**Assessment Boundary:** Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.
### Unit 3: Cellular Reproduction and Inheritance (cont.)

#### Student Learning Objectives: (SLO)
NJSL5/HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

#### Disciplinary Core Ideas
LS3.B: Variation of Traits
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.

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<tbody>
<tr>
<td></td>
<td>Analyzing and Interpreting Data</td>
<td>Scale, Proportion, and Quantity</td>
<td>Activities/Strategies</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>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).</td>
<td>Technology Implementation/Interdisciplinary Connections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>Connections to Nature of Science</td>
<td>Human Genetics activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Science is a Human Endeavor</td>
<td>Technological advances have influenced the progress of science and technology. Science and engineering are influenced by society and society is influenced by science and engineering.</td>
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</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

**Assessment Boundary:** Assessment does not include Hardy-Weinberg calculations.
Biology

Unit 3: Cellular Reproduction and Inheritance (cont.)

**Student Learning Objectives:** (SLO)
NJSLS/HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>LS1.B: Growth and Development of Organisms</td>
<td>Developing and Using Models</td>
<td>Systems and System Models</td>
<td>Mitosis modeling</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.
Unit 4: Evolution and Ecology

Essential Questions: Overarching Phenomena of Interest: Factors that alter the balance of an ecosystem.

- How can there be so many similarities among organisms yet so many different kinds of plants, animals, and microorganisms?
- How do organisms obtain and use energy they need to live and grow?
- How do matter and energy move through ecosystems?
- How do organisms interact with the living and non-living environment to obtain matter and energy?
- How does biodiversity affect humans? How do humans affect biodiversity?
- How do humans impact our environment?

NGSS Performance Expectations: (Students who demonstrate understanding can:)

- NJSL/HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- NJSL/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.
- NJSL/HS-LS2-4 Use mathematically based claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- NJSL/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.
- NJSL/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.
- NJSL/HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- NJSL/HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.
- NJSL/HS-LS3-3: Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. (Revisited in honors classes only)
- NJSL/HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- NJSL/HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- NJSL/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.
- NJSL/HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- NJSL/HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
- NJSL/HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- NJSL/HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- NJSL/HS-ESS-2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.
- NJSL/HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- NJSL/HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- NJSL/HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- NJSL/HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Unit Assessment: (What is the evidence (authentic) that students have achieved the targeted standards/unit objectives?)
- Quarterly Exam

Resources:
Discovery Education Science TechBook: Biology
- Heredity
  - Evolution
- Diversity of Living Things
  - Classification
  - The History of Life on Earth

Discovery Education Science TechBook: Earth and Space Science
- Earth's Systems
  - Cycling of matter and energy

Miller & Levine Biology
- Evolution
  - 17.1 A Voyage of Discovery pg. 544-548
  - 17.2 Ideas that Influenced Darwin pg. 549-554
  - 17.3 Darwin's Theory: Natural Selection pg. 555-559
  - 17.4 Evidence of Evolution pg. 560-567
  - 18.1 Genes and Variation pg. 580-584
  - 18.2 Evolution as Genetic Change pg. 585-591
  - 18.3 The Process of Speciation pg. 592-595
  - 19.2 Modern Evolutionary Classification pg. 619-628
  - 20.1 The Fossil Record pg. 642-651
  - 20.2 Evolutionary Patterns and Processes pg. 652-658
  - 24.4 Social Interactions and Group Behavior pg. 822-827

- Ecology
  - Describing Populations
  - Ecosystems
  - Nutrient cycles
Cengage Biology Concepts and Applications

- Evolution
  - 16.1- Early Beliefs, Confusing Discoveries pg. 254-255
  - 16.2- A Flurry of New Ideas pg. 256-257
  - 16.3- Ancient Evidence pg. 258-259
  - 16.4- Filling in Pieces of the Puzzle pg. 260-261
  - 16.5- Drifting Continents, Changing Seas pg. 262-263
  - 16.6- Putting Time Into Perspective pg. 264-265
  - 16.7- Evidence in Form pg. 266-267
  - 16.8- Evidence in Function pg. 268-269
  - 17.1- Alleles in Populations pg. 274-275
  - 17.2- Genetic Equilibrium pg. 276-277
  - 17.3- Directional Selection pg. 278-279
  - 17.4 Stabilizing and Disruptive Selection pg. 280-281
  - 17.5- Natural Selection and Diversity pg. 282-283
  - 17.6- Genetic Drift and Gene Flow pg. 284-285
  - 17.7- Reproductive Isolation pg. 286-287
  - 17.8- Allopatric Speciation pg. 288-289
  - 17.9- Other Speciation Models pg. 290-291
  - 17.10- Macroevolution pg. 292-293
  - 17.11- Phylogeny pg. 294-295
  - 17.12- Application of Phylogeny pg. 296-297
  - 18.1- Origin of Life’s Building Blocks pg. 302-303
  - 18.2- Polymers to Protocells pg. 304-305
  - 18.3- Early Cellular Life pg. 306-307
  - 18.4- Origin of Eukaryotes pg. 308-309
  - 18.5- Perspective on the Precambrian pg. 310-311
  - 39.1- Factors Affecting Behavior pg. 698-699
  - 39.2- Instinct and Learning pg. 700-701
  - 39.3- Animal Communication pg. 702-703
  - 39.4- Reproductive and Parenting Behavior pg. 704-705
  - 39.5- Group Living and Social Behavior pg. 706-707
  - 39.6- Eusocial Animals pg. 708-709

- Ecology
  - 40.1- Characteristics of a Population pg. 714-715
  - 40.2- Population Size and Exponential Growth pg. 716-717
  - 40.3- Limits on Population Growth pg. 718-719
  - 40.4- Life History Patterns pg. 720-721
  - 40.5- Predation Effects on Life History pg. 722-723
  - 40.6- Human Population Growth pg. 724-725
  - 40.7- Economic Effects and Resource Consumption pg. 726-727
  - 41.1- Factors That Shape Communities pg. 732
  - 41.2- Mutualism pg. 733
  - 41.3- Interspecific Competition pg. 734-735
  - 41.4- Predation and Herbivory pg. 736-737
  - 41.5- Parasites and Parasitoids pg. 738-739
  - 41.6- How Communities Change Over Time pg. 740-741
  - 41.7- Single- Species Effects pg. 742-743
  - 41.8- Island Biogeography pg. 744-745
  - 42.1- The Nature of Ecosystems pg. 750-751
  - 42.2- Depicting Trophic Structure pg. 752-753
  - 42.3- Biogeochemical Cycles pg. 754
  - 42.4- The Water Cycle pg. 754-755
  - 42.5- The Carbon Cycle pg. 756-757
  - 42.6- The Nitrogen Cycle pg. 758-759
  - 42.7- The Phosphorous Cycle pg. 760-761
  - 44.1- Threatened and Endangered Species pg. 786-787
  - 44.2- Desertification and Deforestation pg. 788-789
  - 44.3- Effect of Pollution pg. 790-791
  - 44.4- Ozone Depletion pg. 792
  - 44.5- Global Climate Change pg. 793
  - 44.6- Conservative Biology pg. 794-795
  - 44.7- Reducing Human Impact pg. 796-797

Other Activities

- Evolution
  - Activity on how selective pressure contributes to genetic variation (Honors only)
  - Activity on the role of environment and genetics on distribution of traits (Honors only)
  - Evidence for Evolution activities (ex: homologous structures, embryology, fossil record, molecular evidence …)
  - Apply amino acid sequences to evolution
  - Interpreting graphs
  - Pest management & natural selection
  - Natural Selection simulation (Such as Galapagos Birds)
  - Calculation of Hardy Weinberg (For honors only)
Evaluating impacts of environmental change on population - Evaluating a situation where the environment changes and hypothesizing the change to the population

- Ecology
  - Model the carbon cycle
  - Evaluate how changes to the carbon cycle impact chemical, physical, geological and biological processes
  - Carrying capacity activity with data calculation
  - Food web or chain or pyramid with a representation of energy transfer
  - Illustrate the difference in the number of organisms at each trophic level
  - Research examples of group behavior and how that behavior is used to increase chances of survival
  - Activity in which a change in environment affects an ecosystem (Example: Present students with different scenarios with a change in the ecosystem and ask them to reason out the possible effect of the change on the ecosystem. Use collected/researched evidence to support the conclusion)
  - Analyze data and news articles related to biodiversity in local and global ecosystems
  - Activities on how to minimize/remove human impact. (Example: Have students create an environment including organisms, real or fictitious, and abiotic factors. Then introduce a disturbance to the environment and have students predict what will happen to abiotic and biotic aspects of their environment)
  - Read and interpret data from a source such as Mauna Loa (Carbon cycle) and evaluate human impact

**Suggested Gizmos**

- Ecology
  - Carbon Cycle
  - Coral Reefs 1- Abiotic Factors
  - Coral Reefs 2- Biotic Factors
  - Food Chain
  - Forest Ecosystem
  - Greenhouse Effect- Metric
  - Pond Ecosystem
  - Prairie Ecosystem
  - Rabbit Population by Season
  - Rainfall and Bird Beaks- Metric
  - Water Cycle
  - Water Pollution

- Evolution
  - Cladograms
  - Embryo Development
  - Evolution: Mutation and Selection
  - Evolution: Natural and Artificial Selection
  - Evolution- STEM case
  - Human Evolution - Skull Analysis
  - Microevolution
  - Natural Selection
  - Rainfall and Bird Beaks- Metric

**Essential Materials, Supplementary Materials, Links to Best Practices**

- Discovery Education Science Tech Book
- Miller & Levine Biology
- Cengage Biology Concepts and Applications
- For phenomena ideas: www.NGSSPhenomena.com
- For simulation labs: https://concord.org/stem-resources/subject/biology
- For readings, quizzes, and simulations: www.ck12.org
ELA/ Literacy

RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1),(HS-LS2-2),(HS-LS2-6),(HS-LS2-8), (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4), (HS-ESS3-1),(HS-ESS3-2),(HS-ESS3-4),(HS-ESS3-5)
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)
RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8),(HS-LS4-5),(HS-ESS3-4)
WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS2-7)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1),(HSLSS2-2), (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical ev ents, scientific procedures/ experiments, or technical processes. (HS-ESS3-1)
WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-LS4-6)
WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HSLSS2-7),(HS-LS4-6)
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS4-1),(HS-LS4-2),(HS-LS4-3),(HS-LS4-4),(HS-LS4-5)
SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (HS-LS4-1),(HS-LS4-2)

Math

MP.2 Reason abstractly and quantitatively. (HS-LS2-4)
MP.4 Model with mathematics. (HS-LS2-4)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-LS2-4)
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-4)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-4)

Technology

8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.
8.1.12.D.1 Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.
8.1.12.E.1 Produce a position statement about a real world problem by developing a systematic plan of investigation with peers and experts synthesizing information from multiple sources.
8.2.12.A.1 Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation
8.2.12.A.2 Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste.
8.2.12.A.3 Research and present information on an existing technological product that has been repurposed for a different function.
8.2.12.B.1 Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review.
8.2.12.B.2 Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation and maintenance of a chosen product.
8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants.
8.2.12.B.5 Research the historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product, and present the competing viewpoints to peers for review.
8.2.12.C.6 Research an existing product, reverse engineer and redesign it to improve form and function.
8.2.12.C.7 Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.
8.2.12.D.1 Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review.
8.2.12.D.2 Write a feasibility study of a product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation.
8.2.12.D.6 Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.

**Career Ready Practices**

CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP3. Attend to personal health and financial well-being.
CRP4. Communicate clearly and effectively and with reason.
CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP10. Plan education and career paths aligned to personal goals.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.
### Unit 4: Evolution and Ecology (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Instructional Actions</th>
</tr>
</thead>
</table>
| NJLS/HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. | Activities/Strategies
Technology Implementation/Interdisciplinary Connections |

### Disciplinary Core Ideas

#### LS2.A: Interdependent Relationships in Ecosystems

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 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 given ecosystem.

#### Science and Engineering Practices

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 and/or computational representations of phenomena or design solutions to support explanations. (NJLS/HS-LS2-1)

#### Crosscutting Concepts

**Scale, Proportion, and Quantity**

The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (NJLS/HS-LS2-1)

#### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

**Assessment Boundary:** Assessment does not include deriving mathematical equations to make comparisons.
Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

NJSL/S-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

<table>
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<tbody>
<tr>
<td>LS2.A: Interdependent Relationships in Ecosystems</td>
<td>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, data, 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 representations of phenomena or design solutions to support and revise explanations. (NJSL/S-LS2-2)</td>
<td>Scale, Proportion, and Quantity Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (NJSL/S-LS2-2)</td>
<td>Activities/Strategies Technology Implementation/ Assessment Check Points Analyze data and news articles related to biodiversity in local and global ecosystems Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

**Assessment Boundary:** Assessment is limited to provided data.
| Biology  |

## Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

**NJSLHS/HS-LS2-4:** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Instructional Actions</th>
<th>Activities/Strategies</th>
<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LS2.B:</strong> Cycles of Matter and Energy Transfer in Ecosystems</td>
<td><strong>Using Mathematics and Computational Thinking</strong> 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 representations of phenomena or design solutions to support claims. (NJSLHS/HS-LS2-4)</td>
<td><strong>Energy and Matter</strong> Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (NJSLHS/HS-LS1-7), (NJSLHS/HS-LS2-4)</td>
<td><strong>Instructional Actions</strong></td>
<td><strong>Technology Implementation/Interdisciplinary Connections</strong></td>
<td><strong>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</strong></td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.

**Assessment Boundary:** Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.
**Unit 4: Evolution and Ecology (cont.)**

**Student Learning Objectives:** (SLO)
NJSL/S/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.
(This is revisited from marking period 2. Focus should be on biosphere, atmosphere, hydrosphere and geosphere)

<table>
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</thead>
<tbody>
<tr>
<td><strong>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</strong></td>
<td>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.</td>
<td>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. (NJSL/S/HS-LS2-5)</td>
<td>Model the carbon cycle</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
</tbody>
</table>

**PS3.D: Energy in Chemical Processes**
The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. *(secondary to NJSL/S/HS-LS2-5)*

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of models could include simulations and mathematical models.

**Assessment Boundary:** Assessment does not include the specific chemical steps of photosynthesis and respiration.
## Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)
NJSLS/HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.</td>
<td>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 world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (NJSLS/HS-ESS2-1),(NJSLS/HS-ESS2-3),(NJSLS/HS-ESS2-6)</td>
<td>The total amount of energy and matter in closed systems is conserved.</td>
<td>Model the carbon cycle Evaluate how changes to the carbon cycle impact chemical, physical, geological and biological processes</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.
**Unit 4: Evolution and Ecology (cont.)**

<table>
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<tr>
<td><strong>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</strong></td>
<td>Engaging in Argument from Evidence</td>
<td>Stability and Change</td>
<td>Activity in which a change in environment affects an ecosystem</td>
<td>Tests/Quizzes/Formative Assessments/Labs/Activities/Homework</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>Much of science deals with constructing explanations of how things change and how they remain stable. (NJSLS/HS-LS2-6),(NJSLS/HS-LS2-7)</td>
<td>(Example: Present students with different scenarios with a change in the ecosystem and ask them to reason out the possible effect of the change on the ecosystem. Use collected/researched evidence to support the conclusion)</td>
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<td></td>
<td>Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (NJSLS/HS-LS2-6)</td>
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<tr>
<td></td>
<td><strong>Scientific Knowledge is Open to Revision in Light of New Evidence</strong></td>
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<td></td>
<td>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. (NJSLS/HS-LS2-6),(NJSLS/HS-LS2-8)</td>
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**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.
### Unit 4: Evolution and Ecology (cont.)

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<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Science and Engineering Practices</strong></td>
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<tr>
<td><strong>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</strong> Moreover, 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. (NJSLS/HS-LS2-7)</td>
<td>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.</td>
</tr>
<tr>
<td><strong>LS4.D: Biodiversity and Humans</strong> Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to NJSLS/HS-LS2-7) 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. (secondary to NJSLS/HS-LS2-7),(NJSLS/HS-LS4-6.)</td>
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<tr>
<td><strong>ETS1.B: Developing Possible Solutions</strong></td>
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</tr>
<tr>
<td>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. (secondary to NJSLS/HS-LS2-7),(secondary to NJSLS/HS-LS4-6)</td>
<td></td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of human activities can include urbanization, building dams, and dissemination of invasive species.
# Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

NJSLS/HS-LS2-8: Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

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<tr>
<td><strong>LS2.D: Social Interactions and Group Behavior</strong></td>
<td><strong>Engaging in Argument from Evidence</strong></td>
<td><strong>Cause and Effect</strong></td>
<td>Research examples of group behavior and how that behavior is used to increase chances of survival</td>
<td>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</td>
</tr>
<tr>
<td>Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.</td>
<td>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</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NJSLS/HS-LS2-8)</td>
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<td></td>
<td>Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.</td>
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<tr>
<td><strong>Connections to Nature of Science</strong></td>
<td><strong>Scientific Knowledge is Open to Revision in Light of New Evidence</strong></td>
<td></td>
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<td>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.</td>
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**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.
### Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

NJSLS/HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

(This concept is revisited from Unit 2 in Honors classes only)

<table>
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<tbody>
<tr>
<td>LS3.B: Variation of Traits</td>
<td>Analyzing and Interpreting Data</td>
<td>Scale, Proportion, and Quantity</td>
<td>Technology Implementation/ Interdisciplinary Connections</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td>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. (NJSLS/HS-LS3-2),(NJSLS/HS-LS3-3) distribution of traits observed depends on both genetic and environmental factors. (NJSLS/HS-LS3-2),(NJSLS/HS-LS3-3)</td>
<td>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. (NJSLS/HS-LS3-3)</td>
<td>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). (NJSLS/HS-LS3-3)</td>
<td>Activity on how selective pressure contributes to genetic variation</td>
<td>Activity on the role of environment and genetics on distribution of traits</td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

**Assessment Boundary:** Assessment does not include Hardy-Weinberg calculations.
## Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

NJSLS/HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td><strong>LS4.A: Evidence of Common Ancestry and Diversity</strong></td>
<td><strong>Obtaining, Evaluating, and Communicating Information</strong></td>
<td><strong>Patterns</strong></td>
<td>Evidence for Evolution activities (ex: homologous structures, embryology, fossil record, molecular evidence …)</td>
<td>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</td>
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  - Genetic information, like the fossil record, 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.

  - **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.**

    - 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).

  - **Connections to Nature of Science: Models, Laws, Mechanisms, and Theories Explain Natural Phenomena**

    - A scientific theory is a substantiated explanation of 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.

<table>
<thead>
<tr>
<th><strong>Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems</strong></th>
<th><strong>Application</strong></th>
<th><strong>Assessment Check Points</strong></th>
</tr>
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<tbody>
<tr>
<td>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.</td>
<td><strong>Application</strong></td>
<td><strong>Tests, Quizzes, Formative Assessments, Labs/Activities, Homework</strong></td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.
**Unit 4: Evolution and Ecology (cont.)**

**Student Learning Objectives: (SLO)**
NJSSS/HS-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

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<tr>
<td><strong>LS4.B: Natural Selection</strong></td>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td><strong>Cause and Effect</strong></td>
<td>Interpreting graphs</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td>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.</td>
<td>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.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
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<tr>
<td><strong>LS4.C: Adaptation</strong></td>
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<tr>
<td>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 reproduce in that environment.</td>
<td>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.</td>
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</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on using evidence to explain the influence each of the four factors has on the number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

**Assessment Boundary:** Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.
## Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives:** (SLO)

NJSLs/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.

<table>
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<tr>
<td><strong>LS4.B: Natural Selection</strong></td>
<td>Analyzing and Interpreting Data</td>
<td>Patterns</td>
<td>Activities/Strategies</td>
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<tr>
<td>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.</td>
<td>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.</td>
<td>Natural Selection simulation (Such as Galapagos Birds)</td>
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<tr>
<td><strong>LS4.C: Adaptation</strong></td>
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<td>Calculation of Hardy Weinberg (For honors only)</td>
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<tr>
<td>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</td>
<td>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.</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
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**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.

**Assessment Boundary:** Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations
### Unit 4: Evolution and Ecology (cont.)

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<tr>
<th><strong>Student Learning Objectives:</strong> (SLO)</th>
<th><strong>Instructional Actions</strong></th>
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<tbody>
<tr>
<td>NJSSL/HS-LS 4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.</td>
<td><strong>Activities/Strategies</strong>&lt;br&gt;Technology Implementation/Interdisciplinary Connections</td>
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<td><strong>LS4.C: Adaptation</strong></td>
<td><strong>Designing Solutions</strong></td>
<td><strong>Cause and Effect</strong></td>
<td>Natural Selection simulation</td>
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<tr>
<td>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</td>
<td>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.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
<td>Tests&lt;br&gt;Quizzes&lt;br&gt;Formative Assessments&lt;br&gt;Labs/Activities&lt;br&gt;Homework</td>
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| **Instructional Adjustments:** | **Clarification Statement:** Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations. |

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<td><strong>LS4.C: Adaptation</strong></td>
<td><strong>Designing Solutions</strong></td>
<td><strong>Cause and Effect</strong></td>
<td>Natural Selection simulation</td>
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<td>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</td>
<td>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.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
<td>Tests&lt;br&gt;Quizzes&lt;br&gt;Formative Assessments&lt;br&gt;Labs/Activities&lt;br&gt;Homework</td>
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| **Instructional Adjustments:** | **Clarification Statement:** Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations. |
### Unit 4: Evolution and Ecology (cont.)

**Student Learning Objectives: (SLO)**
NJSLH/HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

**Disciplinary Core Ideas**

<table>
<thead>
<tr>
<th>LS4.C: Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline— and sometimes the extinction— of some species.</td>
</tr>
</tbody>
</table>

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.

**Science and Engineering Practices**

<table>
<thead>
<tr>
<th>Engaging in Argument from Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>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 or historical episodes in science.</td>
</tr>
<tr>
<td>Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.</td>
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</tbody>
</table>

**Crosscutting Concepts**

<table>
<thead>
<tr>
<th>Cause and Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</td>
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**Activities/Strategies**

<table>
<thead>
<tr>
<th>Technology Implementation/Interdisciplinary Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluating impacts of environmental change on population - Evaluating a situation where the environment changes and hypothesizing the change to the population</td>
</tr>
</tbody>
</table>

**Assessment Check Points**

<table>
<thead>
<tr>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quizzes</td>
</tr>
<tr>
<td>Formative Assessments</td>
</tr>
<tr>
<td>Labs/Activities</td>
</tr>
<tr>
<td>Homework</td>
</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.
### Unit 4: Evolution and Ecology (cont.)

#### Student Learning Objectives: (SLO)

NJSLS/HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Activities/Strategies Technology</th>
<th>Assessment Check Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LS4.C: Adaptation</strong></td>
<td>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.</td>
<td>Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NJSLS/HS-LS2-8),(NJSLS/HS-LS4-6)</td>
<td>Activities on how to minimize/remove human impact. (Example: Have students create an environment including organisms, real or fictitious, and abiotic factors. Then introduce a disturbance to the environment and have students predict what will happen to abiotic and biotic aspects of their environment)</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
<tr>
<td><strong>LS4.D: Biodiversity and Humans</strong> 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. <em>(secondary to NJSLS/HS-LS2-7),(NJSLS/HS-LS4-6)</em></td>
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<tr>
<td><strong>ETS1.B: Developing Possible Solutions</strong> 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. <em>(secondary to NJSLS/HS-LS2-7),(secondary to NJSLS/HS-LS4-6)</em></td>
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</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.
### Unit 4: Evolution and Ecology (cont.)

<table>
<thead>
<tr>
<th>Student Learning Objectives: (SLO)</th>
<th>Disciplinary Core Ideas</th>
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<th>Crosscutting Concepts</th>
<th>Instructional Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJSLHS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.</td>
<td><strong>ESS2.D: WEATHER AND CLIMATE</strong>&lt;br&gt;• Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.</td>
<td>Engaging in Argument from Evidence&lt;br&gt;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.&lt;br&gt;• Construct an oral and written argument or counter-arguments based on data and evidence</td>
<td>Stability and Change&lt;br&gt;• Much of science deals with constructing explanations of how things change and how they remain stable.</td>
<td>Activities/Strategies&lt;br&gt;Technology Implementation/Interdisciplinary Connections</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ESS2.E Biogeology</th>
<th>Engaging in Argument from Evidence</th>
<th>Stability and Change</th>
</tr>
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<tbody>
<tr>
<td>• The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it.</td>
<td></td>
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</tr>
</tbody>
</table>

**Instructional Adjustments:** Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth’s surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.

**Assessment Boundary:** Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth’s other systems.
## Unit 4: Evolution and Ecology (cont.)

### Student Learning Objectives: (SLO)
NJLS/HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

### Disciplinary Core Ideas

<table>
<thead>
<tr>
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<th>Science and Engineering Practices</th>
<th>Crosscutting Concepts</th>
<th>Instructional Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS3.A: Natural Resources</td>
<td>Constructing Explanations and Designing Solutions</td>
<td>Cause and Effect</td>
<td>Activities/Strategies Technology Implementation/Interdisciplinary Connections</td>
</tr>
<tr>
<td>Resource availability has guided the development of human society.</td>
<td>Constructing explanations and designing solutions in K–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 knowledge, 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.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NJLS/HS-ESS3-1)</td>
<td>Web Quest</td>
</tr>
<tr>
<td>ESS3.B: Natural Hazards</td>
<td></td>
<td>Influence of Engineering, Technology, and Science on Society and the Natural World</td>
<td></td>
</tr>
<tr>
<td>Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.</td>
<td></td>
<td>Modern civilization depends on major technological systems</td>
<td></td>
</tr>
</tbody>
</table>

### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

### Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.
### Unit 4: Evolution and Ecology (cont.)

<table>
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<tr>
<th>Student Learning Objectives: (SLO)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>NJSL/HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.</td>
<td>Activities/Strategies Technology Implementation/Interdisciplinary Connections Assessment Check Points</td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (NJSL/HS-ESS3-3)</td>
<td>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. Create a computational model or simulation of a phenomenon, designed device, process, or system.</td>
<td>Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. <strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong> Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Science is a Human Endeavor Science is a result of human endeavors, imagination, and creativity.</td>
<td>Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
</tbody>
</table>

### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

### Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.

### Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.
## Unit 4: Evolution and Ecology (cont.)

<table>
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<th>Student Learning Objectives: (SLO)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>NJSL/HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems</td>
<td>Activities/Strategies/ Technology Implementation/ Interdisciplinary Connections</td>
</tr>
</tbody>
</table>

### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th><strong>ESS3.C:</strong> Human Impacts on Earth Systems</th>
<th><strong>ETS1.B:</strong> Developing Possible Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (NJSL/HS-ESS3-4)</td>
<td>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. (secondary to NJSL/HS-ESS3-2), (secondary NJSL/HS-ESS3-4)</td>
</tr>
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### Science and Engineering Practices

<table>
<thead>
<tr>
<th>Constructing Explanations and Designing Solutions</th>
<th>Stability and Change</th>
</tr>
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<tbody>
<tr>
<td>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 knowledge, principles, and theories.</td>
<td>Feedback (negative or positive) can stabilize or destabilize a system. (HSESS3-4)</td>
</tr>
<tr>
<td>Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (NJSL/HS-ESS3-4)</td>
<td><strong>Connections to Engineering, Technology, and Applications of Science</strong></td>
</tr>
<tr>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World</strong></td>
<td>Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HSESS3-2), (NJSL/HS-ESS3)</td>
</tr>
</tbody>
</table>

### Instructional Adjustments: Modifications, student difficulties, possible misunderstandings

**Clarification Statement:** Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).
## Unit 4: Evolution and Ecology (cont.)

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<tr>
<th><strong>Student Learning Objectives</strong>: (SLO)</th>
<th><strong>Instructional Actions</strong></th>
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<tbody>
<tr>
<td>NJSLS/HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.</td>
<td><strong>Activities/Strategies</strong> Technology Implementation/Interdisciplinary Connections <strong>Assessment Check Points</strong> Tests Quizzes Formative Assessments Labs/Activities Homework</td>
</tr>
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### Disciplinary Core Ideas

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<tr>
<th><strong>ESS3.D: Global Climate Change</strong></th>
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<tbody>
<tr>
<td>Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (NJSLS/HS-ESS3-5)</td>
</tr>
</tbody>
</table>

#### 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. Analyze data using computational models in order to make valid and reliable scientific claims.

#### Connections to Nature of Science Scientific Investigations

<table>
<thead>
<tr>
<th><strong>Use a Variety of Methods</strong></th>
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</thead>
<tbody>
<tr>
<td>Science investigations use diverse methods and do not always use the same set of procedures to obtain</td>
</tr>
</tbody>
</table>

#### Stability and Change

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HSESS3-3),(NJSLS/HS-ESS3-5)

<table>
<thead>
<tr>
<th><strong>Scientific Knowledge is Based on Empirical Evidence</strong></th>
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</thead>
<tbody>
<tr>
<td>Science knowledge is based on empirical evidence. Science arguments are strengthened by multiple lines of evidence supporting a single explanation.</td>
</tr>
</tbody>
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### Instructional Adjustments:

Modifications, student difficulties, possible misunderstandings

### Clarification Statement:

Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).

### Assessment Boundary:

Assessment is limited to one example of a climate change and its associated impacts.
## Student Learning Objectives: (SLO)
NJSL/H-S-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>ESS2.D: Weather and Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6)</td>
</tr>
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</table>

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<tr>
<th>ESS3.D: Global Climate Change</th>
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<td>Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (NJSL/H-ESS3-6)</td>
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### Science and Engineering Practices

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<th>Using Mathematics and Computational</th>
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<td>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.</td>
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<th>Systems and System Models</th>
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<tbody>
<tr>
<td>When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (NJSL/H-ESS3-6)</td>
</tr>
</tbody>
</table>

### Crosscutting Concepts

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<tr>
<th>Instructional Adjustments: Modifications, student difficulties, possible misunderstandings</th>
</tr>
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</table>

| Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations. |

| Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models. |

### Instructional Actions

<table>
<thead>
<tr>
<th>Activities/Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Implementation/Interdisciplinary Connections</td>
</tr>
</tbody>
</table>

<table>
<thead>
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</tr>
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