PUBLIC SCHOOLS OF EDISON TOWNSHIP

OFFICE OF CURRICULUM AND INSTRUCTION

Biology

Length of Course:	Term
Elective/Required:	Required
Schools:	High School
Eligibility:	Grade 9
Credit Value:	5 Credits
Date Approved:	August 15, 2023

TABLE OF CONTENTS

Statement of Purpose:

Biology is offered to ninth graders as part of a sequence of college preparatory, laboratory science courses. It is a first year high school course traditionally followed by Chemistry and Physics or Integrated Science. 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, 2018, 2019 and 2023 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), Pivot Interactives, (https://www.pivotinteractives.com/) and Gizmos (www.explorelearning.com).

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Course Objectives

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

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. (Unit 3)

NJSLS/HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (Unit 1 and 2)

NJSLS/HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (Unit 2)

NJSLS/HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (Unit 3)

NJSLS/HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (Unit 2)

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. (Unit 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. (Unit 1)

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. (Unit 1)

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. (Unit 2)

NJSLS/HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. (Unit 1 and 2)

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. (Unit 2)

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. (Unit 1)

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. (Unit 5)

NJSLS/HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Unit 1)

NJSLS/HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. (Unit 1)

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. (Unit 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. (Unit 3)

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

NJSLS/HS-LS4-1 Communicates scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. (Unit 5)

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. (Unit 4 and 5)

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. (Unit 4)

NJSLS/HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (Unit 4 and 5)

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. (Unit 4 and 5)

NJSLS/HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (Unit 1)

Earth and Space Science Standards

NJSLS/HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (Unit 2)

NJSLS/HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (Unit 2)

NJSLS/HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (Unit 5)

NJSLS/HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity. (Unit 1)

NJSLS/HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. (Unit 1)

NJSLS/HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems. (Unit 1)

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. (Unit 1)

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. (Unit 2)

Engineering Design Standards
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. (Unit 1)

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. (Unit 4)

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. (Unit 2)

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. (Unit 1)

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. (Unit 3)

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. (Unit 1)

Reading and Writing Companion Standards:
Key Ideas and Details
RST.11-12.1. Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

RST.11-12.2. Determine the central ideas, themes, or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11-12.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

RST.11-12.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved. Integration of Knowledge and Ideas

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.

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.

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.

Range of Reading and Level of Text Complexity

RST.11-12.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

Progress Indicators for Writing

Text Types and Purposes

WHST.11-12.1. Write arguments focused on discipline-specific content.

A. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
B. Develop claim(s) and counterclaims using sound reasoning and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
C. Use transitions (e.g. words, phrases, clauses) to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
D. Establish and maintain a style and tone appropriate to the audience and purpose (e.g. formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
E. Provide a concluding paragraph or section that supports the argument presented.

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

A. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

B. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
C. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
D. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
E. Provide a concluding paragraph or section that supports the argument presented.

WHST.11-12.3 (See note; not applicable as a separate requirement)

Production and Distribution of Writing
WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11-12.5. 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.

WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge
WHST.11-12.7. 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.

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.

WHST.11-12.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing
WHST.11-12.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Note: Students' narrative skills continue to grow in these grades. The standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Career Readiness, Life Literacies, and Key Skills Practices (21st Century Skills)
Career Readiness, Life Literacies, and Key Skills Practices describe the habits of the mind that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. These practices should be taught and reinforced in all content areas with increasingly higher levels of complexity and expectation as a student advances through a program of study.
The organization and content of the NJSLS-Career Readiness, Life Literacies, and Key Skills include the following areas:

- Standard 9.1 Personal Financial Literacy: This standard outlines the important fiscal knowledge, habits, and skills that must be mastered in order for students to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.
- Standard 9.2 Career Awareness, Exploration, Preparation and Training. This standard outlines the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.
- Standard 9.3: This standard outlines what students should know and be able to do upon completion of a Career Technological Education (CTE) Program of Study.
- Standard 9.4 Life Literacies and Key Skills. This standard outline key literacies and technical skills such as critical thinking, global and cultural awareness, and technology literacy* that are critical for students to develop to live and work in an interconnected global economy.

Practice:	Description:
Act as a responsible and contributing community member and employee.	Students understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.
Attend to financial well-being.	Students take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.
Consider the environmental, social and economic impacts of decisions.	Students understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
Demonstrate creativity and innovation.	Students regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
Utilize critical thinking to	Students readily recognize problems in the workplace, understand the nature

make sense of problems and persevere in solving them.	of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.
Model integrity, ethical leadership and effective management.	Students consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others' actions, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morals and organizational culture.
Plan education and career paths aligned to personal goals.	Students take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.
Use technology to enhance productivity increase collaboration and communicate effectively	Students find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.
Work productively in teams while using cultural/global competence.	Students positively contribute to every team, whether formal or informal. They apply an awareness of cultural differences to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

Pacing Guide by Marking Period

Marking Period 1: (9 weeks)

- Introduction to Biology
    - Characteristics of living things
    - Hierarchy within living systems
    - Emergent properties
- Ecosystems/Biomes
- Interactions of organisms - Symbiosis and competition
- Biogeochemical cycles (Carbon, nitrogen, water)
- Energy Transformations
    - Food webs/chains
    - Energy pyramids
- Population Ecology
    - Carrying capacity
    - Density dependent/independent factors
    - Succession
    - Group behavior
- Biodiversity
- Evaluate a solution to mitigate the effect of human activity on:
    - Climate
    - Changing biodiversity
    - Natural systems

Marking Period 2: (9 weeks)

- Macromolecules- structures and functions
- Homeostasis
    - Positive/negative feedback and examples
    - Factors that affect homeostasis: pH, temperature, water levels
- Membrane Transport
    - Properties of water (polarity and hydrogen bonding)
    - Passive and Active Transport
    - Tonicity
- Cycling of Carbon between Living Things
    - Photosynthesis
    - Cellular Respiration
        - Aerobic respiration
        - Anaerobic respiration

<u>Marking Period 3:</u> (9 weeks)

- Central Dogma
    - DNA structure and replication
    - Protein Synthesis
    - Gene expression
    - Mutations
        - Environmental factors that cause mutations
- Cell Life cycle
    - Cell Cycle
        - Control of cycle
        - Mitosis
        - Apoptosis, cancer and tumors
            - Environmental factors that cause cancer
        - Differentiation
    - Meiosis
        - Ploidy
        - Genetic recombination
            - Independent assortment
            - Crossing over
        - Chromosomal mutations and nondisjunction
        - Karyotypes
    - Fertilization
- Biotechnology

<u>Marking Period 4</u>: (9 weeks)

- Genetics
    - Mendelian genetics
    - Nonmendelian genetics
        - Sex-linkage
        - Codominance/blood types
        - Incomplete dominance
    - Pedigrees
- Evolution
    - Evidence of Evolution
    - Microevolution
        - Natural selection
            - Explain how environments are changing due to climate change which impacts 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
    - Environmental factors that impact
  - Emergence of new species as a result of extinction
  - Reproductive barriers
  - Group behavior
  - Phylogenetic trees/Cladograms

Unit 1: Ecosystems- Interactions and Dynamics

In this unit students figure out big ideas related to energy flow in ecosystems, carrying capacity and interactions including group behavior. They investigate the importance of biodiversity and how human interactions affect natural systems.

Essential Questions
How is matter characterized as living and nonliving and what are the defining components? How are the themes of biology interrelated? How is the scientific method used and applied to experimental discovery? How are biomes influenced by climate and location? What plant life and animal life dominates each biome? How does the environment affect organisms and how do they in turn affect the environment? How are energy and nutrients made available to all members of a community? How are all organisms interdependent through the food web and other interactions? How do populations of organisms grow, at what rate and what limits their growth? What is the impact of human activities on the environment and on organisms and how can we protect biodiversity? How has evolution shaped diversity in ecosystems and life within? What happens to ecosystems when the environment changes?
Student Learning Objectives
Define ecology, biosphere, and ecosystem and explain their organization. Describe the process of ecological succession. Explain how biomes are classified and describe the characteristics of each land biome. Describe the three aquatic biomes and list abiotic factors that affect them. Explain how energy flows through an ecosystem. Discuss how water, nitrogen, carbon, and oxygen are recycled in the environment. Construct a food chain and a food web and discuss the trophic relationships, which they depict. Relate population growth to a population's carrying capacity. Interpret logistic growth curves and distinguish from exponential growth. Distinguish between density dependent and density independent limiting factors. Compare parasitism, commensalism, and mutualism and cite examples of each. Discuss trends in human population growth and how this, combined with human activity, affects biodiversity. Explain the importance of biodiversity and identify ways to protect it.
Topics
1. Themes of biology 2. Levels of organization 3. Steps of scientific method 4. Lab safety/equipment/tools 5. Ecology/species/interaction 6. Food chains/food webs 7. Cycling of matter vs. energy 8. Trophic levels 9. Niche vs. habitat 10. Biogeochemical cycle(s) 11. Human interaction and impact
New Jersey Student Learning Standards (NJSLS)
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-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
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.
NJSLS/HS-LS2-4* Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
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.
NJSLS/HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
NJSLS/HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
NJSLS/HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
NJSLS/HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity.
NJSLS/HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
NJSLS/HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems.
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.
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-ETS1-3 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.

Instructional Adjustments and Clarifications

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.
- Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.
- 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.
- Examples of models could include simulations and mathematical models.
- 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.
- 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.
- Examples of human activities can include urbanization, building dams, and dissemination of invasive species.

- 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.
- 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.
- 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.
- 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.
- Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.
- 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.
- 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.
- 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.
- 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)
- 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).
- Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from 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 deriving mathematical equations to make comparisons.
- Assessment is limited to provided data.
- Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.

- Assessment does not include the specific chemical steps of photosynthesis and respiration.
- Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.
- Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.
- Assessment is limited to one example of climate change and its associated impacts.
- Assessment does not include running computational representations but is limited to using the published results of scientific computational models.

Disciplinary Core Ideas (DCI)

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 would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (NJSLS/HS- LS2-1),(NJSLS/HS-LS2-2)

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

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. (NJSLS/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 NJSLS/HS-LS2-5)* Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen**.**

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (NJSLS/HS-LS2- 2),(NJSLS/HS-LS2-6)

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

LS4.D: Biodiversity and Humans 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.)*

ETS1.B: Developing Possible Solutions

When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.*(secondary to NJSLS/HS-LS2-7),(secondary to NJSLS/HS-LS4-6)*

LS2.D: Social Interactions and Group Behavior

Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

ESS2.D: WEATHER AND CLIMATE

Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

ESS2.E Biogeology

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.

ESS3.A: Natural Resources

Resource availability has guided the development of human society.

ESS3.B: Natural Hazards

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.

ESS3.C: Human Impacts on Earth Systems

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

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (NJSLS/HS-ESS3-4)

ESS3.D: Global Climate Change

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)

ESS2.D: Weather and Climate

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 gasses added to the atmosphere each year and by the ways in which these gasses are absorbed by the ocean and biosphere. (secondary to HSESS3-6)

ESS3.D: Global Climate Change

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. (NJSLS/HS-ESS3-6)

Science and Engineering Practices (SEP)
Mathematical 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. Create a computational model or simulation of a phenomenon, designed device, process, or system.
Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (NJSLS/HS-LS2- 1)
Use mathematical representations of phenomena or design solutions to support and revise explanations. (NJSLS/HS-LS2-2)

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

Develop a model based on evidence to illustrate the relationships between systems or components of a system. (NJSLS/HS- LS2-5)
Create or revise a simulation of a phenomenon, designed device, process, or system. (NJSLS/HS-LS4- 6)

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)

Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (NJSLS/HS- ESS3-6)

Scientific Knowledge is Open to Revision in Light of New Evidence
Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (NJSLS/HS-LS2-2)

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

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

Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (NJSLS/HS- LS2-6)

Construct an oral and written argument or counter-arguments based on data and evidence

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (NJSLS/HS-LS2-7)

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.

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. (NJSLS/HS- ESS3-4)

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.

Analyzing and Interpreting Data

Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (NJSLS/HS- LS3-3)

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

Obtaining, Evaluating, and Communicating Information

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 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.

Use a Variety of Methods
Science investigations use diverse methods and do not always use the same set of procedures to obtain

Use a Variety of Methods
Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
New technologies advance scientific knowledge.

Scientific Knowledge is Based on Empirical Evidence
Science knowledge is based on empirical evidence.
Science arguments are strengthened by multiple lines of evidence supporting a single explanation.

Crosscutting Concepts (CCC)
Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8) **Scale, Proportion, and Quantity**

The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1) Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2) **Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5) **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. (HS-LS2-4) Energy drives the cycling of matter within and between systems. (HS-LS2-3) **Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7) **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3) Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)
Sample Activities/Assessments
Formative- Journal reflections, exit slips, Think/Pair/Share, organizational charts, infographics **Summative**- Tests/quizzes, CER presentations, lab activities and reports **Benchmark assessment** **Sample activities**: ● Characteristics of Living Things: Identify /diagram nested levels of hierarchical structural organization and apply those diagrams to specific human systems ● 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

Cell Types
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

Suggested Pivot Interactives

Animal Behavior: Brine Shrimp and Light
Population Dynamics of Algae
Biodiversity: Pond Microbiomes

Resources

Explore Learning (Gizmos)- all levels of students
Pivot Interactives- all levels of students
Discovery Education Science TechBook- all level of students
Miller & Levine Biology (Pearson 2019)- Level 1 and Level 2 Biology
Biology Concepts and Applications (Cengage 2018)- Honors level
Gateway to Science Vocabulary and Concepts (Collins)- ELL level book

Connections to NJSLS – English Language Arts

• RST.9-10.8 Determine if 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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3), (HS-LS2-6), (HS-LS2-8)
• 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)
• WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3)
• 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-LS2-3)
• 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-LS2-7)

Connections to NJSLS – Mathematics
• MP.2 Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-6), (HS-LS2-7) • MP.4 Model with mathematics. (HS-LS2-1), (HS-LS2-2), (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-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7) • HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7) • HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7) • HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6) • HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6) • HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

Unit 2: Ecosystem- Matter and Energy

In this unit, students focus on the flow of energy and matter through the carbon cycle considering the mechanisms of cellular respiration and photosynthesis at various scales. They consider how humans can develop solutions to reduce their impacts on natural systems.

Essential Questions
1. *How do the structures of molecules enable life's functions?* 2. *How are life's functions adjusted as a result of molecules (Homeostasis)?* 3. *How do the structures of cells enable life's functions?* 4. *How do organisms interact with the living and nonliving environments to obtain matter and energy?* 5. *How do organisms obtain and use the matter and energy they need to live and grow?*
Student Learning Objectives
Explain the connection between the sequence and the subcomponents of a biological polymer and its properties. Pose scientific questions about what mechanisms and structural features allow organisms to capture, store and use energy. Construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store or use energy. Explain how cell size and shape affect the overall intake of nutrients and elimination of waste. Model quantitatively the exchange of molecules between an organism and its environment, and the subsequent use of these molecules to build new molecules that facilitate homeostasis, growth, and reproduction. Use representations and models to pose scientific questions about the properties of cell membranes and selective permeability based on molecular structure. Connect how organisms use negative feedback to maintain their internal environments. Make predictions about how organisms use negative feedback mechanisms to maintain their internal environments. Justify that positive feedback mechanisms amplify responses in organisms. Use representations and models to analyze how cooperative interactions within organisms promote efficiency in the use of energy and matter.
Topics
1. Macromolecules: carbohydrates, lipids, proteins/enzymes, nucleic acids 2. Homeostasis: positive/negative feedback and examples, pH 3. Membrane transport: properties of water, passive and active transport, osmosis 4. Cycling of carbon between living things: photosynthesis, cellular respiration, aerobic respiration, anaerobic respiration
New Jersey Student Learning Standards (NJSLS)
• 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-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. • 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-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.
- 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.
- NJSLS/HS-LS2-4* Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- 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.
- NJSLS/HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- NJSLS/HS-ESS2-6† Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- 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.
- 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.

Instructional Adjustments and Clarifications

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.
- Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water loss.
- Emphasis is on using evidence from models and simulations to support explanations.
- 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.
- 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.
- Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.
- Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.
- Examples of models could include simulations and mathematical models.
- Emphasis is on using data to support arguments for the way variation occurs.

Assessment Boundary:

- Assessment does not include interactions and functions at the molecular or chemical reaction level.
- Assessment does not include the cellular processes involved in the feedback mechanism
- Assessment does not include the details of the specific chemical reactions or identification of macromolecules.
- Assessment does not include interactions and functions at the molecular or chemical reaction level.
- Assessment does not include specific biochemical steps.

- Assessment should not include identification of the steps or specific processes involved in cellular respiration.
- Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.
- Assessment does not include the specific chemical steps of photosynthesis and respiration.

Disciplinary Core Ideas (DCI)

LS1.A: Structure and Function
Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS1.C: Organization for Matter and Energy Flow in Organisms
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. (HS-LS1-6)
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6, HS-LS1-7)
As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bond of food and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)
The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)

Science and Engineering Practices (SEP)

Developing and Using Models
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds
Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
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)

Planning and Carrying Out Investigations
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. (HS-LS1-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6)

Asking Questions and Defining Problems
Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining and evaluating empirically testable questions and design problems using models and simulations.
Ask questions that arise from examining models or a theory to clarify relationships.

Engaging in Arguments from Evidence
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student- generated evidence.

Crosscutting Concepts (CCC)

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

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

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. (HS-LS1-5), (HS-LS1-6)
Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

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

Connections to Nature of Science
Scientific Investigations Use a Variety of Methods
Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Scientific Knowledge is Open to Revision in Light of New Evidence
Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-3)

Sample Activities/Assessments

Formative- Journal reflections, exit slips, Think/Pair/Share, organizational charts, infographics
Summative- Tests/quizzes, CER presentations, lab activities and reports
Benchmark assessment
Sample activities:

- 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
    - Properties of water activity
- 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

Suggested Gizmos

- Dehydration Synthesis
- Digestive System
- Enzymes- STEM case
- Homeostasis
- Human Homeostasis
- Paramecium Homeostasis
- Senses
- Cycling of Carbon Between Living Things
    - Carbon Cycle
    - Cell Energy Cycle
    - Cell Respiration - STEM case
    - Photosynthesis Lab
    - Photosynthesis- STEM case
    - Plants and Snails

Suggested Pivot Labs

- Garden of Splendor: Photosynthesis and Cellular Respiration
- Exploring Respiration Rates
- Catalase Activity Investigation
- Introduction to Cell Respiration
- Lights and Photosynthesis
- Exploring Enzymes: Enzyme concentration
- Introduction to Photosynthesis
- Introduction to Fermentation
- Comparing Human Respiration Before and After Running

Resources

Explore Learning (Gizmos)- all levels of students
Pivot Interactives- all levels of students
Discovery Education Science TechBook- all level of students
Miller & Levine Biology (Pearson 2019)- Level 1 and Level 2 Biology
Biology Concepts and Applications (Cengage 2018)- Honors level
Gateway to Science Vocabulary and Concepts (Collins)- ELL level book

Connections to NJSLS – English Language Arts

• RST.9-10.8 Determine if 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 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3), (HS-LS2-6), (HS-LS2-8)
• 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)
• WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS2-1), (HS-LS2-2), (HS-LS2-3)
• 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-LS2-3)
• 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-LS2-7)

Connections to NJSLS – Mathematics

• MP.2 Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-6), (HS-LS2-7)
• MP.4 Model with mathematics. (HS-LS2-1), (HS-LS2-2), (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-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
• HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)
• HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-7)

- HSS-ID.A.1 Represent data with plots on the real number line. (HS-LS2-6)
- HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. (HS-LS2-6)
- HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

Unit 3: Inheritance and Variation of Traits

Students figure out the role DNA and chromosomes play in human inheritance, how new variations are introduced into populations and how traits are distributed in populations. They investigate how variation leads to differences between individuals at cellular and system levels by disputing and maintaining stable states.

Essential Questions
• *How are the characteristics from one generation related to the previous generation?* • *How does genetic information result in physical characteristics?* • *How is the hereditary information in genes inherited and expressed?* • *How does DNA control growth and function of cells?* • *How do cells grow and reproduce?*
Student Learning Objectives
Justify the selection of data from historical investigations that support the claim that DNA is the source of heritable information. Construct scientific explanations that use the structures and mechanisms of DNA and RNA to support the claim that DNA and, in some cases, that RNA are the primary sources of heritable information. Describe representations and models that illustrate how genetic information is copied for transmission between generations. Describe representations and models illustrating how genetic information is translated into polypeptides. Justify the claim that humans can manipulate heritable information by identifying at least two commonly used technologies. Predict how a change in a specific DNA or RNA sequence can result in changes in gene expression. Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. Make predictions about natural phenomena occurring during the cell cycle. Describe the events that occur in the cell cycle. Construct an explanation, using visual representations or narratives, as to how DNA in chromosomes is transmitted to the next generation via mitosis, or meiosis followed by fertilization. Represent the connection between meiosis and increased genetic diversity necessary for evolution. Evaluate evidence provided by data sets to support the claim that heritable information is passed from one generation to another generation through mitosis, or meiosis followed by fertilization. Construct a representation that connects the process of meiosis to the passage of traits from parent to offspring. Pose questions about ethical, social or medical issues surrounding human genetic disorders. Apply mathematical routines to determine Mendelian patterns of inheritance provided by data sets. Explain deviations from Mendel’s model of the inheritance of traits. Explain how the inheritance patterns of many traits cannot be accounted for by Mendelian genetics. Predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. Explain the connection between genetic variations in organisms and phenotypic variations in populations.
Topics
• Central Dogma: DNA structure and replication, protein synthesis, gene expression, mutations • Life cycle: cell cycle, control of cycle, mitosis, apoptosis, cancer and tumors, differentiation, meiosis, ploidy, fertilization • Genetic recombination: independent assortment, crossing over • Karyotypes: chromosomal mutations, nondisjunction • Gene technology • Genetics: Mendelian genetics, non-mendelian genetics (sex-linkage, codominance/blood types, incomplete dominance), pedigrees

New Jersey Student Learning Standards (NJSLS)
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. NJSLS/HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. 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. 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. NJSLS/HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. 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.
Instructional Adjustments and Clarifications
Instructional Adjustments: modifications, student difficulties, possible misunderstandings. **Clarification Statement:** ● Examples of models could include simulations and mathematical models. ● Emphasis is on using data to support arguments for the way variation occurs. ● 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 the phases of meiosis or the biochemical mechanism of specific steps in the process. ● Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis. ● Assessment does not include interactions and functions at the molecular or chemical reaction level. ● Assessment does not include specific biochemical steps. ● Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process. ● Assessment does not include Hardy-Weinberg calculations.
Disciplinary Core Ideas (DCI)
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 HS-LS3-1 note: this Disciplinary Core Idea is 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. (HS-LS3-1)

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

LS3.B: Variation of Traits
In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)
Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2, HS-LS3-3)

Science and Engineering Practices (SEP)

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

Analyzing and Interpreting Data
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1- 6),(HS-LS2-3)

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)

Engaging in Arguments from Evidence

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

Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student- generated evidence. (HS-LS3-2)

Crosscutting Concepts (CCC)

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

Scale, Proportion, and Quantity
Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)
Connections to Nature of Science Science is a Human Endeavor
Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)
Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

Scientific Knowledge is Open to Revision in Light of New Evidence
Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (NJSLS/HS-LS2-3)

Sample Activities/Assessments

Formative- Journal reflections, exit slips, Think/Pair/Share, organizational charts, infographics
Summative- Tests/quizzes, CER presentations, lab activities and reports
Benchmark assessment
Sample activities:
- 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)
- Life Cycle
  - Mitosis modeling
  - Karyotype activity
- Genetics
  - Punnett Square problems and activities
  - Human genetics lab activity

Suggested Gizmos
- Building DNA
- RNA and Protein Synthesis
- 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)

Suggested Pivot Interactives

- What Contains DNA?
- Control of Gene Expression with PhET
- Gel Electrophoresis Basics
- Gene Regulation: Yeast and Galactose
- Mitosis in Onion Root Tip
- Plant Genetics – single trait
- Fruit Fly Genetics – single trait, two trait crosses, sex linked
- Linked genes

Resources
Explore Learning (Gizmos)- all levels of students Pivot Interactives- all levels of students Discovery Education Science TechBook- all level of students Miller & Levine Biology (Pearson 2019)- Level 1 and Level 2 Biology Biology Concepts and Applications (Cengage 2018)- Honors level Gateway to Science Vocabulary and Concepts (Collins)- ELL level book

Connections to NJSLS – English Language Arts
• RST.11-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. (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)

Connections to NJSLS – Mathematics
• MP.2 Reason abstractly and quantitatively. (HS-LS3-2), (HS-LS3-3)

Unit 4: Natural Selection and Evolution of Populations

In this unit, students investigate evolution by natural selection and apply these ideas to populations. Students use these understandings to propose a solution to a global problem related to change in populations over time.

Essential Questions
• *What evidence is there to support the theory of evolution?* • *What role does the environment play in an organism's survival and reproduction?* • *How do species change over time?*
Student Learning Objectives
Evaluate evidence provided by data to qualitatively and quantitatively investigate the role of natural selection in evolution. Apply mathematical methods to data from a real or simulated population to predict what will happen to the population in the future. Evaluate data-based evidence that describes evolutionary changes in the genetic makeup of a population over time. Connect evolutionary changes in a population over time to a change in the environment. Use data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations. Justify data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations. Analyze data related to questions of speciation and extinction throughout the Earth’s history. Design a plan for collecting data to investigate the scientific claim that speciation and extinction have occurred throughout the Earth’s history. Use data from a real or simulated population(s), based on graphs or models of types of selection, to predict what will happen to the population in the future. Justify the selection of data that address questions related to reproductive isolation and speciation. Describe speciation in an isolated population and connect it to change in gene frequency, change in environment, natural selection and/or genetic drift. Describe a model that represents evolution within a population. Evaluate given data sets that illustrate evolution as an ongoing process.
Topics
• Microevolution: natural selection, adaptations, artificial selection, sexual selection, antibiotic and pesticide resistance, genetic drift (bottleneck effect, founder effect, mutation), and gene flow • Hardy Weinberg (Honors and level 1) • Speciation
New Jersey Student Learning Standards (NJSLS)
• 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 . • 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 • NJSLS/HS-LS4-4* Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

- 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.
- 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.

Instructional Adjustments and Clarifications

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.
- Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.
- 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.
- 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.
- 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.
- 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.
- Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.
- 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 deriving mathematical equations to make comparisons.
- Assessment is limited to provided data.
- Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations
- Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.

Disciplinary Core Ideas (DCI)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

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. (HS-LS2-7)

LS4.B: Natural Selection
Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

LS4.C: Adaptation
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. (HS-LS4-2)
Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)
Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)
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. (HS-LS4-5), (HS-LS4-6)
Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

LS4.D: Biodiversity and Humans
Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life onEarth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-LS4-6)
Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6)

Science and Engineering Practices (SEP)

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)

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.** Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** **Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2), (HS-LS4-4) **Engaging in Argument from Evidence** **Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.** Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5) **Obtaining, Evaluating, and Communicating Information** **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). (HS-LS4-1)
Crosscutting Concepts (CCC)
Patterns Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3) **Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HSLS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6) **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4) **Connections to Nature of Science** **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. (HS-LS4-1)

Sample Activities/Assessments

Formative- Journal reflections, exit slips, Think/Pair/Share, organizational charts, infographics
Summative- Tests/quizzes, CER presentations, lab activities and reports
Benchmark assessment
Sample activities:

- 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

Suggested Gizmos
Embryo Development
Evolution: Mutation and Selection
Evolution: Natural and Artificial Selection
Evolution- STEM case
Microevolution
Natural Selection
Rainfall and Bird Beaks- Metric

Suggested Pivot Interactives
Natural Selection with PhEt

Resources

Explore Learning (Gizmos)- all levels of students
Pivot Interactives- all levels of students
Discovery Education Science TechBook- all level of students
Miller & Levine Biology (Pearson 2019)- Level 1 and Level 2 Biology
Biology Concepts and Applications (Cengage 2018)- Honors level
Gateway to Science Vocabulary and Concepts (Collins)- ELL level book

Connections to NJSLS – English Language Arts

• 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-ESS1-1), (HS-ESS1-2), (HS-ESS1-5), (HS-ESS1-6)
• 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-ESS1-5), (HS-ESS1-6)
• WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS1-6)
• WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-5)
• SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3)

• SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-6)
Connections to NJSLS – Mathematics
• MP.2 Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6) • MP.4 Model with mathematics. (HS-ESS1-1), (HS-ESS1-4) • 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-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6) • HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6) • HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)

Unit 5: Common Ancestry and Speciation

In this unit students use their understanding of evolution through natural selection to explore the evidence for common ancestry and figure out how Earth's systems and life co-evolved. They investigate speciation and extinction through this lens.

Essential Questions
• *How do we scientifically explain the evidence and mechanisms for biological evolution?* • *How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms?* • *What evidence shows that different species are related?*
Student Learning Objectives
Evaluate evidence provided by data from many scientific disciplines that support biological evolution. Refine evidence based on data from many scientific disciplines that support biological evolution. Design a plan to answer scientific questions regarding how organisms have changed over time using information from morphology, biochemistry and geology. Connect scientific evidence from many scientific disciplines to support the modern concept of evolution. Construct and/or justify mathematical models, diagrams or simulations that represent processes of biological evolution. Pose scientific questions about a group of organisms whose relatedness is described by a phylogenetic tree or cladogram in order to (1) identify shared characteristics, (2) make inferences about the evolutionary history of the group, and (3) identify character data that could extend or improve the phylogenetic tree. Evaluate evidence provided by a data set in conjunction with a phylogenetic tree or a simple cladogram to determine evolutionary history and speciation. Create a phylogenetic tree or simple cladogram that correctly represents evolutionary history and speciation from a provided data set. Justify the scientific claim that organisms share many conserved core processes and features that evolved and are widely distributed among organisms today.
Topics
• Evidence of evolution: similarities in development and molecular and anatomical structure, fossils, biogeography • Cladograms/phylogenetic trees • Coevolution • Endosymbiont Theory
New Jersey Student Learning Standards (NJSLS)
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. NJSLS/HS-LS4-1 Communicates scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. 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 . NJSLS/HS-LS4-4* Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

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. NJSLS/HS-ESS2-7† Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
Instructional Adjustments and Clarifications
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. ● Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data. ● 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. ● 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. ● 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. ● 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. ● Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations. ● 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 deriving mathematical equations to make comparisons. ● Assessment is limited to provided data. ● Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations ● Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.
Disciplinary Core Ideas (DCI)
LS2.C: Ecosystem Dynamics, Functioning, and Resilience

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. (HS-LS2-7)

LS4.A: Evidence of Common Ancestry and Diversity
Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)

LS4.D: Biodiversity and Humans
Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life onEarth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-LS4-6)
Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6)

Science and Engineering Practices (SEP)

Analyzing and Interpreting Data
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)

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.
Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2), (HS-LS4-4)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.
Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

Obtaining, Evaluating, and Communicating Information
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). (HS-LS4-1)

Crosscutting Concepts (CCC)

Patterns
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3)

Cause and Effect
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6)

Connections to Nature of Science
Scientific Knowledge Assumes an Order and Consistency in Natural Systems
Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4)

Connections to Nature of Science
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. (HS-LS4-1)

Sample Activities/Assessments

Formative- Journal reflections, exit slips, Think/Pair/Share, organizational charts, infographics
Summative- Tests/quizzes, CER presentations, lab activities and reports
Benchmark assessment
Sample activities:
- Drawing and interpreting phylogenetic trees and cladograms
- Evidence of Evolution Comparative Anatomy Packet
- Your Inner Fish Activity (PBS)
- PBS Cladograms and Phylogenetic Tree Activity

Suggested Gizmos
- Cladograms
- Human Evolution - Skull Analysis

Suggested Pivot Interactives

- Dichotomous Key
- Phylogeny: Plant or Protist

Resources

Explore Learning (Gizmos)- all levels of students
Pivot Interactives- all levels of students
Discovery Education Science TechBook- all level of students
Miller & Levine Biology (Pearson 2019)- Level 1 and Level 2 Biology
Biology Concepts and Applications (Cengage 2018)- Honors level
Gateway to Science Vocabulary and Concepts (Collins)- ELL level book

Connections to NJSLS – English Language Arts

• 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-ESS1-1), (HS-ESS1-2), (HS-ESS1-5), (HS-ESS1-6)
• 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-ESS1-5), (HS-ESS1-6)
• WHST.9-12.1 Write arguments focused on discipline-specific content. (HS-ESS1-6)
• WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-5)
• SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3)
• SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1), (MS-ESS2-2), (MS-ESS2-6)

Connections to NJSLS – Mathematics

• MP.2 Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
• MP.4 Model with mathematics. (HS-ESS1-1), (HS-ESS1-4)
• 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-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
• HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)
• HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-4), (HS-ESS1-5), (HS-ESS1-6)