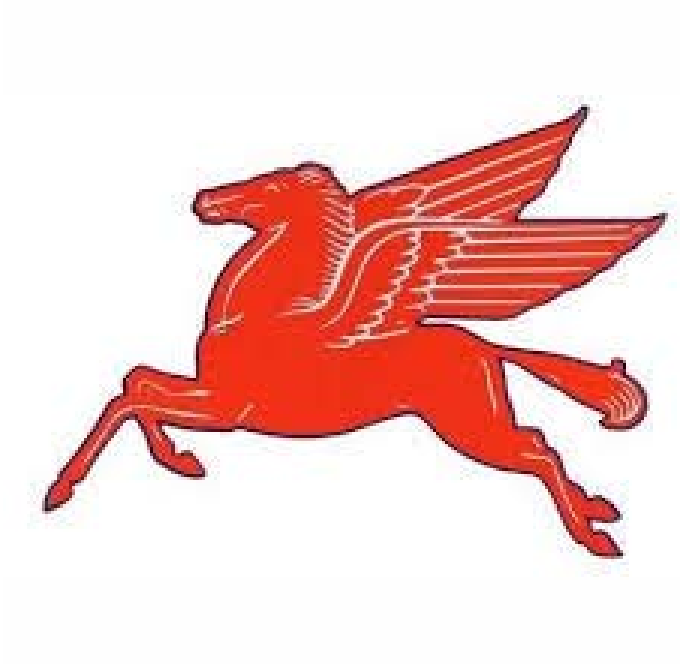
Curriculum Management System

PAULSBORO PUBLIC SCHOOLS



Biology: Various Grade Levels

UPDATED JUNE 2016

For adoption by all regular education programs as specified and for adoption or adaptation by all Special Education Programs in accordance with Board of Education Policy.

Board Approved: August 2016

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Paulsboro Public Schools

Mission Statement

The mission of the Paulsboro School District is to provide each student the educational opportunities to assist in attaining their full potential in a democratic society. Our instructional programs will take place in a responsive, community based school system that fosters respect among all people. Our expectation is that all students will achieve the New Jersey Core Curriculum Content Standards (NJCCCS) at every grade level.

New Jersey State Department of Education
21st Century College and Career Readiness Standards

The 12 Career Ready Practices

These practices outline the skills that all individuals need to have to truly be adaptable, reflective, and proactive in life and careers. These are researched practices that are essential to career readiness.

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

MODIFICATIONS

Special Education:
Students Hands on activity, cooperative learning, peer tutoring, extended time, reteach in utilizing various methods. Utilize remediation resources which include assessment and intervention, in planning and instruction.

English Language Learners:
Provide hands-on activities and explanations. Use reduced text, so that print is not so dense. Assess comprehension through demonstration or other alternative means (gestures, drawings). Give instructions/directions in writing and orally. Use of translation dictionaries to locate words in the native language.
Use English Learners resources such as study guides, assessments and a visual glossary.

At-Risk Students:
Hands on activities cooperative learning, reteach using various methods. Make use of remediation lessons and quizzes when appropriate.

Gifted and Talented Students:
Utilize Pre-AP Resources such as the pacing, assignment and best practices guide.

New Jersey State Department of Education 21st Century College and Career Readiness Standards

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CRP11. Use technology to enhance productivity.

CRP12. Work productively in teams while using cultural global competence.

LAL STANDARDS

LA.9-10.W.9-10.2.A-E

LA.9-10.W.9-10.7

LA.9-10.SL.9-10.1

LA.9-10.SL.9-10.2

LA.9-10.SL.9-10.4

LA.9-10.SL.9-10.5

LA.9-10.L.9-10.4

LA.11-12.W.11-12.2

LA.11-12.W.11-12.7

LA.11-12.SL.1.A

LA.11-12.SL.1.C

LA.11-12.SL.11-12.2

LA.11-12.SL.11-12.4

LA.11-12.SL.11-12.5

LA.11-12.L.11-12.4

LA.11-12.L.11-12.6

Scope and Sequence

Quarter 1 – Biology

Big Idea: How do matter and energy cycle through ecosystems: In this unit of study, students construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration, and they will develop models to communicate these explanations. Students also understand organisms' interactions with each other and their physical environment and how organisms obtain resources. Students utilize the crosscutting concepts of matter and energy and systems, and system models to make sense of ecosystem dynamics. Students are expected to use students construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They apply mathematical concepts to develop evidence to support explanations as they demonstrate their understanding of the disciplinary core ideas (HS-LS1-5, HS-LS2-3, HS-LS2-4, and HS-LS2-5)	**Big Idea: How do organisms interact with the living and nonliving environments to obtain matter and energy?** In this unit of study, students formulate answers to the question "how and why do organisms interact with each other (biotic factors) and their environment (abiotic factors), and what affects these interactions?" Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems. The crosscutting concepts of scale, proportion, and quantity and stability and change are called out as organizing concepts for the disciplinary core ideas. Students are expected to use mathematical reasoning and models to demonstrate proficiency with the disciplinary core ideas. (HS-LS2-1, HS-LS2-2, and HS-LS2-6)

Scope and Sequence

Quarter 2 – Biology_

Big Idea: How do humans depend on Earth's resources? How and why do humans interact with their environment and what are the effects of these interactions? In this unit of study, students examine factors that have influenced the	**Big Idea: Human Activity and Biodiversity** In this unit of study, mathematical models provide support for students' conceptual understanding of systems and students' ability to design, evaluate, and refine solutions for reducing the impact of human activities on the environment and maintaining biodiversity. Students create or revise a

distribution and development of human society; these factors include climate, natural resource availability, and natural disasters. Students use computational representations to analyze how earth systems and their relationships are being modified by human activity. Students also develop an understanding of how human activities affect natural resources and of the interdependence between humans and Earth's systems, which affect the availability of natural resources. Students will apply their engineering capabilities to reduce human impacts on earth systems and improve social and environmental cost–benefit ratios. The crosscutting concepts of cause and effect, systems and systems models, stability and change, and the influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for the disciplinary core ideas. Students will analyze and interpret data, use mathematical and computational thinking, and construct explanations as they demonstrate understanding of the disciplinary core ideas. (HS-ESS3-1, HS-ESS3-6, HS-ESS3-5, HS-ESS3-4, and HS-ETS1-3)	simulation to test solutions for mitigating adverse impacts of human activity on biodiversity. Crosscutting concepts of systems and system models play a central role in students' understanding of science and engineering practices and core ideas of ecosystems. Mathematical models also provide support for students' conceptual understanding of systems and their ability to develop design solutions for reducing the impact of human activities on the environment and maintaining biodiversity. (HS-ESS3-3, HS-LS2-7, HS-LS4-6, HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, and HS-ETS1-4)
Scope and Sequence	
Quarter 3 – Biology ___	
Big Idea: How do the structures of organisms enable life's functions? Students formulate an answer to the question "How do the structures of organisms enable life's functions?" Students investigate explanations for the structure and functions of cells as the basic unit of life, of hierarchical organization of interacting organ systems, and of the role of specialized cells	**Big Idea: How are characteristics from one generation related to the previous generation?** Students analyze data develop models to make sense of the relationship between DNA and chromosomes in the process of cellular division, which passes traits from one generation to the next. Students determine why

for maintenance and growth. The crosscutting concepts of structure and function, matter and energy, and systems and system models are called out as organizing concepts for the disciplinary core ideas. Students use critical reading, modeling, and conducting investigations. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas. (HS-LS1-1, HS-LS1-2, HS-LS1-3, and HS-LS1-4)	individuals of the same species vary in how they look, function, and behave. Students develop conceptual models of the role of DNA in the unity of life on Earth and use statistical models to explain the importance of variation within populations for the survival and evolution of species. Ethical issues related to genetic modification of organisms and the nature of science are described. Students explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expressions. The crosscutting concepts of structure and function, patterns, and cause and effect are used as organizing concepts for the disciplinary core ideas. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas. (HS-LS1-4, HS-LS3-1, and HS-LS3-2)

Scope and Sequence

Quarter 4 – Biology ___

Big Idea: How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms?

Students constructing explanations and designing solutions, analyzing and interpreting data, and engaging in argument from evidence investigate to make sense of the relationship between the environment and natural selection. Students also develop an understanding of the factors causing natural selection of species over time. They also demonstrate and understandings of how multiple lines of evidence contribute to the strength of scientific theories of natural selection. The crosscutting concepts of patterns and cause and effect serve as organizing concepts for the disciplinary core ideas. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.
(LS4.C (Adaptation), HS-LS4-4, HS-LS4-3, HS-LS4-5, and HS-LS2-8.)

Big Idea: What evidence shows that different species are related?
Students construct explanations for the processes of natural selection and evolution and then communicate how multiple lines of evidence support these explanations. Students evaluate evidence of the conditions that may result in new species and understand the role of genetic variation in natural selection. Additionally, students can apply concepts of probability to explain trends in population as those trends relate to advantageous heritable traits in a specific environment. Students demonstrate an understanding of these concepts by obtaining, evaluating, and communicating information and constructing explanations and designing solutions. The crosscutting concepts of patterns and cause and effect support the development of a deeper understanding.
(HS-LS4-1 and HS-LS4-2)

QUARTER 1 –
Big Idea: How do matter and energy cycle through ecosystems – 20 days
Topic: Matter and Energy Cycles

Standards:

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

Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. (HS-LS2-3)

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

Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (HS-LS2-5)

Apply appropriate academic and technical skills. (CRP2)

Communicate clearly and effectively and with reason. (CRP4)

Use technology to enhance productivity. (CRP11)

GOAL

Students will construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They will apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration, and they will develop models to communicate these explanations

Essential Questions

Why do astrobiologists look for water on planets and not oxygen when they search for life on other planets?

Why is there no such thing as a food chain?

How does ecosystem disruption affect humans?

What are two abiotic factors that affect biome?

What is the relationship between ecosystem and community?

How does an ecosystem form, and how does it recover from a disaster?

What is the relationship between the 10% rule and the food web?

What is the relationship between an organism's niche and its placement in the food web?

Why are biogeochemical cycles important?

How do humans affect the biogeochemical cycles?

How can the process of photosynthesis and respiration in a cell impact ALL of Earth's systems?

Assessments

Formative: participation in team activities, research, verbal communication, observations, experiments

Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following:

Construct and revise an explanation for the cycling of matter and flow of energy in aerobic and anaerobic conditions, based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review)

Construct and revise an explanation for the cycling of matter and flow of energy in aerobic and anaerobic conditions, considering that most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.

Support claims for the cycling of matter and flow of energy among organisms in an ecosystem using conceptual thinking and mathematical representations of phenomena.

Use a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and to show how

		matter and energy are conserved as matter cycles and energy flows through ecosystems. Use a mathematical model to describe the conservation of atoms and molecules as they move through an ecosystem. Use proportional reasoning to describe the cycling of matter and flow of energy through an ecosystem. Develop a model, based on evidence, to illustrate the roles of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere, showing the relationships among variables in systems and their components in the natural and designed world.
	Enduring Understanding	**Resources**
	Energy drives the cycling of matter within and between systems in aerobic and anaerobic conditions. Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. At each link in an ecosystem, matter and energy are conserved. 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. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ A variety of models, including computer simulations, diagrams, and drawings, could be used to enhance visual, verbal, and/or written understanding of the various ecological cycles Student-generated pyramids of biomass and food webs could illustrate the flow of energy throughout the ecosystem Students must also construct and revise an explanation of matter cycling and energy flowing in aerobic and anaerobic conditions based on valid and reliable evidence obtained from a variety of sources. Students might use various pyramids (e.g., energy, biomass) and calculate the amount of available energy at each trophic level.

	exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.	Students can also analyze diagrams of chemical cycles (carbon, nitrogen, water, etc.) to identify the movement of matter within ecosystems. Through the use of diagrams, concept maps, or computer models, students will examine how energy is cycled within systems. Students will examine how energy drives the cycling of matter, using diagrams of ecosystems to map the flow of energy and the simultaneous changes in matter. Student explanations should demonstrate an understanding of the relationship between photosynthesis and cellular respiration.

QUARTER 1 –

Big Idea: How do organisms interact with the living and nonliving environments to obtain matter and energy – 20 days

Topic: Ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions

Standards:

Illustrate how interactions among living systems and with their environment result in the movement of matter and energy. (LS2.A)

Provide evidence that the growth of populations are limited by access to resources, and how selective pressures may reduce the number of organisms or eliminate whole populations of organisms. (LS2.A)

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (HS-LS2-1)

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (HS-LS2-2)

Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. (HS-LS2-6)

GOAL

Students will formulate answers to the question "how and why do organisms interact with each other (biotic factors) and their environment (abiotic factors), and what affects these interactions?" Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students will use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems.

Essential Questions	Assessments
How has the introduction of technology changed human population growth patterns? What are the different forms of symbiosis, and how do they affect the organisms involved? What are some resources that can cause competition? How can competition affect species niche and interactions?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. Use quantitative analysis to compare relationships among interdependent factors and represent their effects on the carrying capacity of ecosystems at different scales. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. Use the concept of orders of magnitude to represent how factors affecting biodiversity and populations in ecosystems at one scale relate to those factors at another scale.

Apply appropriate academic and technical skills. (CRP2) **Communicate clearly and effectively and with reason.** (CRP4) **Consider the environmental, social and economic impacts of decisions.** (CRP5)		Evaluate the claims, evidence, and reasoning that support the contention that complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. Construct explanations of how modest biological or physical changes versus extreme changes affect stability and change in ecosystems.
	Enduring Understanding	**Resources**
	Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, completion, and disease. Quantitative analysis can be used to compare and determine relationships among interdependent factors that affect the carrying capacity of ecosystems at different scales. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Using the concept of orders of magnitude allows one to understand how a model of factors affecting biodiversity and populations in ecosystems at one scale relates to a model at another scale.	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ In order to build an understanding of the factors that limit carrying capacities of organisms and populations, students could view and analyze quantitative data from graphs, charts, simulations, and historical data sets of population changes to determine cause-and-effect relationships that lead to change over time. Emphasis should be on having students make quantitative analysis and comparisons of the relationships among interdependent factors, including boundaries, resources, climate, and competition. When choosing materials for analysis, data should be presented at different scales, and students should use units as a way to understand the factors that affect carrying capacity of ecosystems at different scales. Students might also generate charts, graphs, and histograms from data sets. When reporting quantities representing the factors that affect carrying capacity of ecosystems, students should consider any limitations on measurement. Mathematical and computational representations can be used to show that organisms would have the capacity to produce populations of great size were it not for the fact that environments and

	Much of science deals with constructing explanations of how things change and how they remain stable. 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.	resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. Students can use quantitative analysis (e.g., graphs and other data displays with appropriate units and scale) to compare and determine how relationships among interdependent factors such as famine, disease, competition, predation, and shelter affect the carrying capacity of ecosystems at different scales. Examples of different scales could be data sets showing the population dynamics of an ecosystem in a jar, predator–prey oscillation studies, introduction of invasive species into an ecosystem, or changes as a result of the natural process of succession. Through relevant reading experiences, students might also develop and write explanations, citing textual evidence, for factors that affect carrying capacity of ecosystems. In their explanations, students should select the most significant and relevant facts, extended definitions, concrete details, and quotations to support their explanations. Using food webs and ecological models/states, students can observe that the numbers and types of organisms are relatively constant over long periods of time under stable conditions. In order to make mathematical representations to support claims, students need to examine data showing the complex set of interactions that occur in ecosystems. Students should examine data illustrating the quantitative fluctuations in populations that occur because of factors such as predator–prey relationships, availability of resources, and habitat availability.

QUARTER 2 –

Big Idea: How do humans depend on Earth's resources? How and why do humans interact with their environment and what are the effects of these interactions – 20 days

Topic: Factors that influence the distribution and development of human society; these factors include climate, natural resource availability, and natural disasters

Standards:	GOAL	
Illustrate how interactions among living systems and with their environment result in the movement of matter and energy. (LS2.A) **Graph real or simulated populations and analyze the trends to understand consumption patterns and resource availability, and make predictions as to what will happen to the population in the future**. (LS2.A) **Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. (HS-LS2-1)** **Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (HS-LS2-2)** **Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain**	Students will examine factors that have influenced the distribution and development of human society; these factors include climate, natural resource availability, and natural disasters. Students will use computational representations to analyze how earth systems and their relationships are being modified by human activity. Students will also develop an understanding of how human activities affect natural resources and of the interdependence between humans and Earth's systems, which affect the availability of natural resources.	
	Essential Questions	Assessments
	What are the effects of air pollution? How might burning fossil fuels lead to climate change? What are some sources of water pollution? Why is soil erosion a problem?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Construct an explanation based on valid and reliable evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. Use empirical evidence to differentiate between how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. Use a computational representation to illustrate the relationships among Earth systems and how

relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. (HS-LS2-6) **Utilize critical thinking to make sense of problems and persevere in solving them.** (CRP8) **Use technology to enhance productivity.** (CRP11) **Work productively in teams while using cultural global competence.** (CRP12)		these relationships are being modified due to human activity. Describe the boundaries of Earth systems. Analyze and describe the inputs and outputs of Earth systems Analyze geosciences 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. Quantify and model change and rates of change in geosciences data and rates of global or regional climate change and associated impacts to Earth systems. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems based on scientific knowledge and student-generated sources of evidence; prioritize criteria and tradeoff considerations.
	Enduring Understanding	**Resources**
	Resource vitality has guided the development of human society. Natural hazards and other geologic events have shaped the course of human history. Natural hazards and other geologic events have significantly altered the sizes of human populations and have driven human migration. Empirical evidence is required to differentiate between cause and correlation and make claims about how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activities. Modern civilization depends on major technological systems.	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ Students will use their understanding of photosynthesis, cellular respiration, and the carbon cycle from prior units and examine their relationship to climate change and human impact on climate. They will develop an understanding of how human activity can influence the complex set of interactions within an ecosystem, causing changes in the number of different types of species. Students will also build on the idea that anthropogenic changes (induced by human activity) in the environment, including habitat destruction, pollution, introduction of invasive

	Changes in climate can affect population or drive mass migration. Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. Ecosystems have carrying capacities, which are limits to the number of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, completion, 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. 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. Using the concept of orders of magnitude allows one to understand how a model of factors affecting biodiversity and populations in ecosystems at one scale relates to a model at another scale. 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.	species, overexploitation, and climate change, can disrupt an ecosystem and threaten the survival of some species. All of these concepts support students' understanding of human dependence on Earth's resources, human interactions with the environment, and human impacts on Earth's systems. Student understanding of these relationships could be enhanced by examining and citing evidence from text or other investigations that show correlations between human population distribution and regional availability of resources such as fresh water, fertile soils, and fossils fuels. Students should look for cause-and-effect relationships between human population distribution and resource availability and distinguish between causality and correlation. Historical accounts of natural disasters (e.g., Krakatoa eruption, American Dust Bowl, Superstorm Sandy, and Hurricane Katrina) resulting human suffering and loss of life could provide empirical evidence of past impacts on human population size and distribution. Previous climate change events (sea level fall and rise, desertification of the Sahara) could be studied as examples of natural events that can drive human migrations. Students should use evidence from data analysis to make inferences and predictions about the impacts of future climate change and global warming on displacement or migration of humans. When examining and reporting data, students should represent resource availability, natural disasters, and human activity symbolically and determine what quantitative relationships exist. Students might map these relationships in graphs, charts, or other descriptive models, while considering any limitations on measurement when reporting quantities. Students should describe the boundaries of

		Earth’s systems by looking at models, data sets, or graphics showing temperatures and currents of the ocean and atmosphere. They should identify evidence to support the claim that human activity can modify Earth's systems. In their research, students should integrate and evaluate multiple sources of information and verify data when possible. Students could then design a solution to decrease the amount of carbon dioxide added by human activity. When evaluating or refining a technological solution that reduces impacts of human activities on natural systems, such as use of alternative energy sources, students should read and integrate multiple sources of information to create a coherent understanding of the problem. In their evaluation, they should consider costs, benefits, and risks of systems created by engineers. When evaluating solutions, students should take into account a range of constraints, including costs, safety, and reliability, as well as any social, cultural, and environmental impacts.

QUARTER 2 –
Big Idea: Human Activity and Biodiversity – 20 days
Topic: Human Impact on Biodiversity

Standards:	GOAL	
Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. (HS-ESS3-3) **Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** (HS-LS2-7) **Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.** (HS-LS4-6) **Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** (HS-ETS1-1) **Design a solution to a complex real-world problem by breaking it down into smaller, more**	Mathematical models provide support for students' conceptual understanding of systems and students' ability to design, evaluate, and refine solutions for reducing the impact of human activities on the environment and maintaining biodiversity. Students create or revise a simulation to test solutions for mitigating adverse impacts of human activity on biodiversity	
	Essential Questions	**Assessments**
	How might we change habits if we replaced the word "environment" with the word "life support system"? Does reducing human impacts on our global life support system require social engineering or mechanical engineering Is the damage done to the global life support system permanent?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Quantify and model change and rates of change in the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity based on scientific knowledge, student-generated sources of

manageable problems that can be solved through engineering. (HS-ETS1-2) **Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** (HS-ETS1-3) **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.** (HS-ETS1-4) **Act as a responsible and contributing citizen and employee.** (CRP1) **Apply appropriate academic and technical skills.** (CRP2) **Communicate clearly and effectively and with reason.** (CRP4) **Consider the environmental, social and economic impacts of decisions.** (CRP5) **Demonstrate creativity and innovation.** (CRP6) **Employ valid and reliable research strategies.** (CRP7)		evidence, prioritized criteria, and tradeoff considerations. Construct explanations for how the environment and biodiversity change and stay the same when affected by human activity. Evaluate a solution for reducing the impacts of human activities on the environment and biodiversity based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Analyze costs and benefits of a solution for reducing the impacts of human activities on the environment and biodiversity based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. Create or revise a simulation based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations to test a solution to mitigate adverse impacts of human activity on biodiversity. Use empirical evidence to make claims about the impacts of human activity on biodiversity. Break down the criteria for the design of a simulation to test a solution for mitigating adverse impacts of human activity on biodiversity into simpler ones that can be approached systematically based on consideration of trade-offs. Design a solution for a proposed problem related to threatened or endangered species or to genetic variation of organisms for multiple species. Analyze costs and benefits of a solution to mitigate adverse impacts of human activity on biodiversity.
	Enduring Understanding	Resources

	The sustainability of human societies and the biodiversity that supports them require responsible management of natural resources. Change and rates of change can be quantified and modeled over very short or very long periods. Some system changes are irreversible. Modern civilization depends on major technological systems. New technologies can have deep impacts on society and the environment including some that are not anticipated. Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. Much of science deals with constructing explanations of how things change and how they remain stable. When evaluating solutions, it is important to take into account a range of constraints—including costs, safety,	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ Change and rates of change in biodiversity and environmental conditions should be quantified and modeled by students over short and long periods of time. Students should keep in mind that some system changes are irreversible. In their research, students should synthesize information from multiple sources and evaluate claims about the impacts of human activity on biodiversity based on analysis of evidence. Students should create a computational simulation or mathematical model illustrating the relationships among management of natural resources, the sustainability of human populations, and biodiversity. Simulations should model change and rates of change in those relationships. When possible, students should symbolically and quantitatively represent natural resource management, sustainability of human populations, and biodiversity. Students should also map relationships discovered, considering limitations on measurement when reporting quantities or data. Students should understand that sustaining biodiversity is critical to maintaining functional ecosystems. Students might collect data on growth patterns (exponential, logistic) and carrying capacity. Students could use data to make informed decisions about how environmental issues affect their communities politically, economically, and ecologically. Students should connect scientific knowledge to human endeavors, imagination, and creativity using conceptual simulations that illustrate relationships such as those between the management of natural resources in local New England fisheries or the lobster-harvesting

	reliability, and aesthetics—and to consider social, cultural, and environmental impacts. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. 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 ecosystems' 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. Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. 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. Both physical models and computers can be used in various ways to aid the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test ways of solving a problem or to see which one is most efficient or economical,	industry, the needs of the human population, and the effect on marine diversity. Students can use data collected to model changes in marine animal populations to better understand the relationship between management of natural resources, biodiversity, and the sustainability of human populations. Students can also investigate and research major contributions of scientists and engineers who have developed technologies to produce less pollution and waste in order to prevent ecosystem degradation. Students should synthesize information from multiple sources to construct explanations and verify claims about how the environment and biodiversity change and stay the same when affected by human activity. Students could be tasked with designing and evaluating a solution for a proposed problem related to threatened or endangered species or to genetic variation of organisms for multiple species. As they consider a design solution, they should know that technological advances by modern civilizations have solved, and sometimes caused, problems related to human interactions with the environment. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. Students may need to determine long- and short-terms goals of a potential solution, while considering that new technologies can have deep impacts on society and the environment, including some that were not anticipated. Students might use empirical evidence of decreasing bird populations to differentiate between specific causes and effects.

	and in making a persuasive presentation to a client about how a given design will meet his or her needs. Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	Students could choose an adverse practice and research solutions to associated problems. They might consider wind turbines, deforestation, waste management, noise pollution, or automobile fuel (hydrogen, electricity, water). Solutions for minimizing adverse effects should account for a range of constraints such as cost, safety, reliability, and aesthetics, as well as social, cultural, and environmental impacts, since practical solutions are more likely to be implemented by society.

QUARTER 3–

Big Idea: How do the structures of organisms enable life's functions – 20 days

Topic: Biomolecules, Mitosis, DNA to protein

Standards:	GOAL	
Explain the connection between the sequence and the subcomponents of a biomolecule and its properties. (LS1.A) **Create representations that explain how genetic information flows from a sequence of nucleotides in a gene to a sequence of amino acids in a protein**. (LS1.A) **Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. (HS-LS1-1)**	Students formulate an answer to the question "*How do the structures of organisms enable life's functions?*" Students investigate explanations for the structure and functions of cells as the basic unit of life, of hierarchical organization of interacting organ systems, and of the role of specialized cells for maintenance and growth.	
	Essential Questions	**Assessments**
	How does the structure of DNA determine the structure of proteins, and what is the function of proteins? What do you mean they say that people are made of a system of systems? How do feedback mechanisms maintain homeostasis? Why aren't all elephants the same size?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.

Construct models that explain the movement of molecules across membranes with membrane structure and function. (LS1.A) **Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (HS-LS1-2)** **Provide examples and explain how organisms use feedback systems to maintain their internal environments.** (LS1.A) **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (HS-LS1-3)** **Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (HS-LS1-4)** **Utilize critical thinking to make sense of problems and persevere in solving them.** (CRP8) **Use technology to enhance productivity.** (CRP11)		Construct an explanation, based on 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, for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells. Conduct a detailed examination of the structure and function of DNA. Develop and use a model based on evidence to illustrate hierarchical organization of interacting systems that provide specific functions within multicellular organism. Develop and use a model based on evidence to illustrate the interaction of functions at the organism system level. Develop and use a model based on evidence to illustrate the flow of matter and energy within and between systems of an organism at different scales. Plan and conduct an investigation individually and collaboratively to produce evidence that feedback mechanisms (negative and positive) maintain homeostasis. Use a model based on evidence to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Use a model to illustrate the role of cellular division and differentiation in terms of energy, matter, and information flows within and between systems of cells/organisms.

	Enduring Understanding	**Resources**
	Systems of specialized cells within organisms help them perform the essential functions of life. All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. 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 their functions and/or solve a problem. 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. 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. Feedback mechanisms maintain a living system's internal conditions within certain limits, and they mediate behaviors, allowing the system 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. Feedback (negative or positive) can stabilize or destabilize a system. 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	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ Students should conduct a detailed examination of the structure and function of DNA by building a model of DNA to demonstrate their knowledge of Chargaff's Rule. Models can also be used to illustrate the processes of transcription and translation to clarify the function of DNA in terms of protein synthesis. Students should also draw and cite evidence from informational texts to support an explanation for how the structure of DNA determines the structure of proteins. Models (e.g. physical, mathematical, and computer models) could be used by students to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. Students should also examine matter and energy transfers within and between systems of an organism at different scales. Students should use models and oral presentations to simulate maintenance and development within complex organisms by mitosis and cell differentiation. Students need an understanding of how external conditions affect the internal conditions of an organism. Feedback mechanisms maintain the internal conditions of living systems within a limited range, in part due to mediated behaviors such as basking, use of shade, mud baths, and burrowing. These feedback mechanisms can encourage or discourage physiological responses in living systems. Students can investigate sugar, oxygen, and temperature regulations, individually and collaboratively, to produce evidence that

	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.	feedback mechanisms maintain homeostasis. In planning their investigations, students should conduct research and synthesize information from multiple reliable sources to support claims about how feedback mechanisms maintain homeostasis. Students should investigate and model the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Students should identify important quantities in the role of cellular division and differentiation and use mathematical models to illustrate how these processes produce and maintain complex organisms. Models might include data showing numbers of cells at different stages of development. Data could be collected from observing the different stages of mitosis using a microscope or virtual/computer simulation. Graphs and functions could be used to show growth rate in terms of cell division

QUARTER 3 –

Big Idea: How are characteristics from one generation related to the previous generation – 20 days

Topic: Meiosis and genetic variation

Standards:

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

Explain *how* the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity necessary for evolution. (LS1.B)

Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (HS-LS3-1)

Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced. (LS3.B)

GOAL

Students analyze data develop models to make sense of the relationship between DNA and chromosomes in the process of cellular division, which passes traits from one generation to the next. Students determine why individuals of the same species vary in how they look, function, and behave. Students develop *conceptual models* of the role of DNA in the unity of life on Earth and *use statistical models* to explain the importance of variation within populations for the survival and evolution of species. Ethical issues related to genetic modification of organisms and the nature of science are described. Students explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expressions.

Essential Questions	Assessments
What can't two roses ever be identical? How does inheritable genetic variation occur? Can a zoologist predict the distribution of expressed traits in a population?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Ask questions that arise from examining models or a theory to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parent to offspring.

Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. (HS-LS3-2) **Apply appropriate academic and technical skills.** (CRP2) **Communicate clearly and effectively and with reason.** (CRP4) **Use technology to enhance productivity.** (CRP11)		Use empirical evidence to differentiate between cause and correlation and make claims about the role of DNA and chromosomes in coding the instructions for characteristics passed from parents to offspring. Make and defend a claim based on evidence that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors. Use data to support arguments for the ways inheritable genetic variation occurs. Use empirical evidence to differentiate between cause and correlation and make claims about the ways inheritable genetic variation occurs. Use mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits. Use algebraic thinking to examine scientific data on the variation and distribution of traits in a population and predict the effect of a change in probability of traits as it relates to genetic and environmental factors.
	Enduring Understanding	**Resources**
	All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. Each chromosome consists of a single, very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in the DNA.	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ Students should identify the terms genes, chromosomes, and histones to develop an understanding that genes are regions in the DNA that contain the instructions that code for the formation of proteins. In addition, students should know that each chromosome consists of a single, very long DNA molecule, and that each gene on the chromosome is a particular segment of that DNA.

	All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have, as yet, no known function. Empirical evidence is required to differentiate between cause and correlation and to make claims about the role of DNA and chromosomes in coding the instructions for the characteristic traits passed from parents to offspring. In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Environmental factors also affect expression of traits, and hence affect the probability of occurrence of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. Algebraic thinking is used to examine scientific data and predict the distribution of traits in a population as they relate to the genetic and environmental factors (e.g., linear growth vs. exponential growth). Technological advances have influenced the progress of science, and science has influenced advances in technology. Science and engineering are influenced by society, and society is influenced by science and engineering.	Students might demonstrate that all cells in an organism have the same genetic content by using paper models, manipulatives, or computer simulations to simulate DNA replication. Students should synthesize information and cite specific evidence from texts, experiments, or simulations to gain a coherent understanding of and support explanations about the relationship between the role of DNA and chromosomes in coding instructions for characteristic traits passed from parents to offspring. Students should also research and investigate types of DNA, including DNA that codes for proteins, hemoglobin, actin, myosin), DNA that is involved in regulatory or structural functions (cell membrane proteins, cyclins) and DNA that has no known function (introns). To understand environmental influence on gene expression, a study and evaluation of empirical evidence detailing frequencies of different forms of cancer could be correlated with specific environmental factors (climate, diet, pollution, lifestyle). Students should then determine whether cause-and-effect relationships exist. Students should also make claims about the relationship between the role of DNA and chromosomes in coding for characteristic traits passed from parent to offspring. Students should make and defend claims, citing evidence from text, about how inheritable genetic variations may result from new genetic combinations. Ideally, student-conducted experiments will yield empirical evidence correlating the inheritable variation to the cause. Students should make and defend claims about the ways variation occurs using this empirical evidence. Students must understand that although DNA replication is tightly regulated, mutation can occur and can result in genetic variations.

		Students should be provided with the opportunity to determine the probability of occurrence of traits in a population using mathematical models. Through these activities, students will observe and predict the variation and distributions of traits and connect their expression to both genetic and environmental factors. In developing mathematical models to represent the variation and distribution of expressed traits, students should make sense of quantities and relationships in order to make predictions about the expression of traits. The variation and distribution of traits depend on both genetic and environmental factors. Students should understand how environmental factors affect the expression of traits and the probability of trait occurrences in populations. Students should be able make predictions as they relate to gene frequencies in populations affected by both genetic and environmental factors. Students should be aware that technology and science are related and that technological advances have influenced the progress of science. Science in turn influences advances in technology, such as in the development of gene therapies. Students should have an understanding of how science and engineering are influenced by society (e.g., need for cures for genetic diseases), and how society is influenced by science and technology (e.g., the bio-ethics and economics of genetically modified foods).

QUARTER 4 –

Big Idea: How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms – 20 days

Topic: Natural Selection and Adaptation

Standards:	GOAL	
Make predictions about the effects of artificial selection on the genetic makeup of a population over time. (LS4.C) **Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** (**HS-LS4-4**) **Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** (**HS-LS4-3**)	Students *constructing explanations* and *designing solutions*, *analyzing and interpreting data*, and *engaging in argument from evidence investigate* to make sense of the relationship between the environment and natural selection. Students also develop an understanding of the factors causing natural selection of species over time. They also demonstrate and understandings of how multiple lines of evidence contribute to the strength of scientific theories of natural selection. The crosscutting concepts of *patterns* and *cause and effect* serve as organizing concepts for the disciplinary core ideas. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas	
	Essential Questions	Assessments
	How does natural selection lead to adaptations of populations? Why is it so important to take all of the antibiotics in a prescription if I feel better? How are species affected by changing environmental conditions?	Formative: participation in team activities, research, verbal communication, observations, experiments Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following:

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. (HS-LS4-5) **Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. (HS-LS2-8)** **Act as a responsible and contributing citizen and employee.** (CRP1) **Apply appropriate academic and technical skills.** (CRP2) **Communicate clearly and effectively and with reason.** (CRP4) **Consider the environmental, social and economic impacts of decisions.** (CRP5) **Demonstrate creativity and innovation.** (CRP2) **Employ valid and reliable research strategies.** (CRP7) **Utilize critical thinking to make sense of problems and persevere in solving them.** (CRP8) **Use technology to enhance productivity.** (CRP11)	Why do some species live in groups and others are solitary?	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 on 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, for how natural selection leads to adaptation of populations. Use data to differentiate between cause and correlation and to make claims about how specific biotic and abiotic differences in ecosystems contribute to change in gene frequency over time, leading to adaptation of populations Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. Analyze shifts in numerical distribution of traits and, using these shifts as evidence, support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. Observe patterns at each of the scales at which a system is studied to provide evidence for causality in explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait 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. Determine cause-and-effect relationships for how changes to the environment affect distribution or disappearance of traits in species.

		Use empirical evidence to differentiate between cause and correlation and to make claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. Distinguish between group and individual behavior, identify evidence supporting the outcome of group behavior and develop logical and reasonable arguments based on evidence to evaluate the role of group behavior on individual and species' chances to survive and reproduce. Use empirical evidence to differentiate between cause and correlation and to make claims about the role of group behavior on individual and species' chances to survive and reproduce.
	Enduring Understanding	**Resources**
	Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. Empirical evidence is required to differentiate between cause and correlation and make claims about how natural selection leads to adaptation of populations. Empirical evidence is required to differentiate between cause and correlation and make claims about how specific biotic and abiotic differences in ecosystems contribute to change in gene frequency over time, leading to adaptation of populations.	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ Empirical evidence (including students' own investigations, models, theories, simulations, peer review) should be used to differentiate between cause and correlation and to make claims about how natural selection leads to adaptation of populations. Students should make sense of quantities and relationships between specific biotic and abiotic differences in ecosystems and their contributions to a change in gene frequency over time that leads to adaptation of populations, paying attention to proportional increases in organisms with advantageous heritable traits. Students should use data to provide evidence for how specific biotic and abiotic differences in

	Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future. Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. Adaptation also means that the distribution of traits in a population can change when conditions change. Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline, and sometimes the extinction, of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. Empirical evidence is required to differentiate between cause and correlation and make claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species	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. To enhance understanding, students should examine scientific text and cite specific textual evidence to support analysis and explanations for how natural selection leads to change in populations over time. Students should examine how individuals possessing certain forms of inherited traits may have a survival advantage over others in the population. Increased survival and reproductive success in these individuals can cause advantageous traits to become more common in the population. In other words, the population adapts to its environment. This process of change over time, as the environment "selects" for advantageous forms of heritable traits, is called natural selection. This process could be experienced by students through a variety of hands-on experiments. Many computer simulations are available that allow students to manipulate changes in the environment and observe how the population changes as individuals with advantageous traits survive and reproduce, while those lacking these traits die in greater numbers before reproducing. From experiments such as these, students can collect numerical data and observe that while the total number of individuals in the population may remain relatively constant, the traits represented in that population can change in response to environmental change. Species extinction can also result from faster or drastic changes limiting the possibilities of species evolution. Students can investigate claims in order to support how environmental conditions may result in an increase in the number of species, emergence of new species over time, or

	Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. Empirical evidence is required to differentiate between cause and correlation and to make claims about the role of group behavior in individual and species' chances to survive and reproduce. Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in the revision of an explanation about the role of group behavior on individual and species' chances to survive and reproduce.	in the extinction of other species. Students should determine the cause-and-effect relationships involved in how changes in the environment affect the distribution or disappearance of traits in a specific species. Addressing how changes to the environment affect the distribution or disappearance of traits in a species could be explained from a cause-and-effect perspective. In their research, students should evaluate hypotheses, data, analysis, and conclusions about how changes in environmental conditions may result in changes in the numbers of some species. They should support their findings with evidence. Group behavior of organisms has evolved because membership can increase the chance of survival for individuals and their genetic relatives. Students should collect empirical data that differentiates between cause and correlation relating to the survival rate of species and group behaviors. Students should develop logical and reasonable arguments to clarify the strength of the relationship and interactions between ideas and evidence that may be used to explain the role of group behavior on survival rate.

QUARTER 4 –

Big Idea: Evolution – 20 days

Topic: Evolution via Natural Selection

Standards:	GOAL	
Examine a group of related organisms using a phylogenic 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. (LS4.A) **Communicate scientific information that common ancestry and biological evolution are**	Students construct explanations for the processes of natural selection and evolution and then communicate how multiple lines of evidence support these explanations. Students evaluate evidence of the conditions that may result in new species and understand the role of genetic variation in natural selection. Additionally, students can apply concepts of probability to explain trends in population as those trends relate to advantageous heritable traits in a specific environment. Students demonstrate an understanding of these concepts by *obtaining, evaluating, and communicating information* and *constructing explanations and designing solutions*.	
	Essential Questions	Assessments
	How can someone prove that birds and dinosaurs are related? What is the relationship between natural selection and evolution?	Formative: participation in team activities, research, verbal communication, observations, experiments

supported by multiple lines of empirical evidence. (HS-LS4-1) **Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment**. (HS-LS4-2) **Apply appropriate academic and technical skills.** (CRP2) **Communicate clearly and effectively and with reason.** (CRP4) **Consider the environmental, social and economic impacts of decisions.** (CRP5) **Employ valid and reliable research strategies.** (CRP7) **Utilize critical thinking to make sense of problems and persevere in solving them.** (CRP8) **Use technology to enhance productivity.** (CRP11)		Benchmark/Summative: Interactive Science assessments, formal lab sheets, experiments that may address the following: Communicate scientific information in multiple forms that common ancestry and biological evolution are supported by multiple lines of empirical evidence. Understand the role each line of evidence has relating to common ancestry and biological evolution. Observe patterns in multiple lines of empirical evidence at different scales and provide evidence for causality in explanations of common ancestry and biological evolution. 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, 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. Use empirical evidence to explain the influences of: (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, on 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.
	Enduring Understanding	**Resources**
	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. 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. Different patterns in multiple lines of empirical evidence may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of common ancestry and biological evolution. 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. 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	Interactive Science Series NJ DOE Model Curriculum NGSS www.nextgenscience.org/ NSTA www.nsta.org/ In this unit of study, students should communicate scientific information related to the evidence for evolution and evolutionary relationships between organisms. Students should analyze DNA sequences, amino acid sequences in proteins, and homologous structures in organisms using various models. Models might include illustrations of embryonic development, amino acid sequences, and cladograms. Students should be able to identify patterns in multiple lines of empirical evidence in order to develop an understanding of the role each line of evidence has in supporting common ancestry and biological evolution. Students will also need to construct and write explanations supported by evidence from text and build on previous experiences to promote a deeper understanding of natural selection. Students should understand that 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. Students can construct explanations using quantitative models, such as histograms, that are

	organisms that are better able to survive and reproduce in that environment. Empirical evidence is required to differentiate between cause and correlation and make claims about the process of evolution.	based on valid and reliable evidence obtained from a variety of sources such as investigations, graphs, tables, and simulations. Students might demonstrate comprehension by drawing evidence from informational text describing common ancestry and biological evolution. Explanations should be supported by analysis, reflection, and research. Students could also share this information with others by way of oral presentations, written reports, or technology-based presentations. Students might research the range of human birth weights illustrating stabilizing selection, in which individuals too small or too large are selected against. The use of antibiotics and pesticides also can be used to further understand directional selection for an extreme phenotype. The result of these investigations reinforces the concept that the natural world operates today as it has in the past and the future. Students will learn that within the process of evolution, there is a potential for species to increase in number. Mutation and sexual reproduction can generate genetic variation, and species compete for limited resources. These factors influence survivorship, reproduction, and the proliferation of species with adaptive phenotypes. Students can research the relationship between phenotypic variation and survivorship.