ROBBINSVILLE PUBLIC SCHOOLS

OFFICE OF CURRICULUM AND INSTRUCTION

Science Department

College Prep Biology

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*Adapted from State of NJ Model Curriculum, & Aligned with NGSS

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BOARD OF EDUCATION INITIAL ADOPTION DATE:

Course Philosophy

The Robbinsville School District Science Department has designed the College Prep Biology curriculum to be suitable for junior level students. The course builds upon foundational knowledge about the natural world from previous science courses, namely the exploration of the fundamental forces of the universe in physics, as well as the atomic interactions of all matter in chemistry. Here, the focus shifts to an exploration of life as a phenomenon on Earth, a planet with unique features to support the existence of biological entities. Emphasis is placed on understanding and appreciating the connections between life at every scale, from the tiniest microscopic interactions within cells to the large-scale macroscopic interactions of organism populations across the planet. Given this emphasis, the course is also an essential introduction to major global concerns affecting all life, such as biodiversity loss, climate change, and public health issues. The science department therefore believes the course will prepare students to become globally conscious critical thinkers who are more aware of their connection to all living things, and who can therefore make informed decisions about their own health and impacts on the planet.

Course Description

College Prep Biology is a laboratory-based course introducing students to the breadth of biological knowledge, ranging from immense macroscopic interactions between organisms to small-scale microscopic phenomena. The course is designed to provide students with hands-on laboratory experiences and explorations of central themes in biology, with an emphasis on the connections between various levels of biological organization. Major themes and topics covered include ecosystems and biodiversity loss, the Goldilocks Planet and Earth's cycles, cellular organization and disease, DNA and genetics, and the process of evolution. As such, the course presents an introductory framework for exploring how human lives are impacted by and connected to all other scales of life on the planet.

Core and Supplemental Instructional Materials

Core Materials	Supplemental Materials
• Prentice Hall *Biology* textbook and associated resources	• "Gizmos" (ExploreLearning.com) • "The Habitable Planet" (www.learner.org/courses/envsci/) • HHMI BioInteractive Simulations • Student -designed lab investigations

	• Teacher -created POGILS and handouts

Social Emotional Learning Connections

Below are the five core SEL Competencies as outlined by CASEL, and examples of how each may be addressed within this curriculum

Self-awareness: The ability to accurately recognize one's emotions and thoughts and their influence on behavior. This includes accurately assessing one's strengths and limitations and possessing a well-grounded sense of confidence and optimism.

Example 1: As scientists, students must recognize their own strengths and limitations to work towards discovering new knowledge.
Example 2: Students explore how their thoughts and feelings may influence their perceptions of and express opinions on scientific phenomena.

Self-management: The ability to regulate one's emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling impulses, motivating oneself, and setting and working toward achieving personal and academic goals.

Example 1: The scientific method requires that individuals persevere through intellectual challenges and work towards their goals.
Example 2: By engaging in the structured scientific process, students hone their ability to regulate emotions and behaviors as they progress toward a goal.

Social awareness: The ability to take the perspective of and empathize with others from diverse backgrounds and cultures, to understand social and ethical norms for behavior, and to recognize family, school, and community resources and supports.

Example 1: Scientists must consider the varied perspectives that people from different backgrounds may have on scientific issues.
Example 2: By engaging in explorations of life science, students will develop awareness about large scale issues affecting different groups of people.

Relationship skills: The ability to establish and maintain healthy and rewarding relationships with diverse individuals and groups. This includes communicating clearly, listening actively, cooperating, resisting inappropriate social pressure, negotiating conflict constructively, and seeking and offering help when needed.

Example 1: The scientific process is collaborative, requiring students and scientists to foster healthy and constructive relationships with peers.
Example 2: Clear communication and active listening are essential tools for generating new scientific knowledge.

Responsible decision-making: The ability to make constructive and respectful choices about personal behavior and social interactions based on consideration of ethical standards, safety concerns, social norms, the realistic evaluation of consequences of various actions, and the well-being of self and others.

Example 1: Scientists must consider the ethical implications as well as the social consequences of their research when pursuing knowledge.

Example 2: Citizens must apply scientific evidence to evaluate the impacts of their actions on their own health, society, and the planet.

Integration of 21st Century Themes and Skills

NJSLS-CLKS 9.4: Life Literacies and Key Skills	
Creativity and Innovation	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 1, 2, 3, 4, 5
Critical Thinking and Problem Solving	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 1, 2, 3, 4, 5
Digital Citizenship	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 3, 4
Global and Cultural Awareness	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 1, 2, 3
Information and Media Literacy	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 1, 2, 3, 4, 5
Technology Literacy	*See specific standards and their connections/examples for this disciplinary concept listed within each individual unit* Can be found in unit: 3, 4

Robbinsville Ready 21st Century Skill Integration

The following skills will be embedded throughout the curriculum and instruction of this course.

Collaborative Team Member: Robbinsville students will learn more by working together than in isolation. As educational theorist Lev Vygotsky advocated, learning is a social process. Many workplaces today encourage employees to work in teams to solicit diverse perspectives, brainstorm new ideas and/or products, and solve problems. Further, collaboration fosters interpersonal relationships, self-management skills, cooperation, and a sense of collective responsibility. Collaborative team members are able to work with diverse groups of people who hold a variety of perspectives.

Effective Communicator: Robbinsville students must be able to clearly articulate their ideas orally, in writing, and across various media in order to successfully connect to the world around them. As the world becomes increasingly globalized, communication is more than just sharing one's ideas. Effective communicators are able to communicate their convictions, actively listen and analyze others' work to identify perspective and/or potential bias.

Emotionally Intelligent Learner: Robbinsville students who are emotionally intelligent learn to be empathetic, demonstrate integrity and ethical behavior, are kind, are self-aware, willing to change, and practice self-care. They are better able to cope with the demands of the 21st century digital society and workplace because they are reliable, responsible, form stable and healthy relationships, and seek to grow personally and professionally. Emotionally intelligent people are able to manage their emotions, work effectively on teams and are leaders who can grow and help to develop others.

Informed and Involved Citizen: Robbinsville students need to be digital citizens who are civically and globally aware. The concept of what it means to be "literate" has evolved along with 21st century technological and cultural shifts. Our progressive vision of literacy entails having our students explore real world problems in the classroom. Informed and involved citizens are able to safely and accurately communicate with people all around the world and are financially, environmentally and informationally literate.

Innovative Thinker: Robbinsville students must encompass innovative thinking skills in order to be successful lifelong learners in the 21st century world. As stated by Karl Fisch and Scott McLeod in the short film Shift Happens, "We are currently preparing students for jobs that don't yet exist . . . using technologies that haven't been invented . . . in order to solve problems we don't even know are problems yet." Innovative thinkers are able to think analytically, solve problems critically, creatively engage in curiosity and tinkering, and demonstrate originality.

Resilient and Self-Directed Learner: Robbinsville students need to take risks and ultimately make independent and informed decisions in an ever-changing world. Author of Life, the Truth, and Being Free, Steve Maraboli stated, "Life doesn't get easier or more forgiving, we get stronger and more resilient." Self-directed scholars of the 21st century are able to set goals, initiate resolutions by seeking creative approaches, and adjust their thinking in light of difficult situations. Resilient students are able to take risks without fear of failure and overcome setbacks by utilizing experiences to confront new challenges. Resilient and self directed scholars will consistently embrace opportunities to initiate solutions and overcome obstacles.

Career Awareness and Planning Standards 9.2	
9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment	**Example**: Students learn about different career paths available in the life and health sciences throughout the course, often taking on these careers as fictitious roles to solve problems.
9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.	**Example**: Students will be encouraged to decide if their postsecondary education plans will include pursuing the natural sciences. If so, they will be encouraged to begin taking steps towards achieving this goal, such as taking higher level science courses and volunteering.
9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.	**Example**: Students will gain valuable analytic, collaborative, and communicative skills throughout all units in the course, and will be encouraged to consider how these skills may manifest in their own future careers, regardless of the field.

Robbinsville Public Schools
Scope, Sequence, Pacing and Assessment

College Prep Biology

Unit Title	Unit Understandings and Goals	Recommended Duration/ Pacing	Assessments
Networks of Life: Ecosystems and Biodiversity Loss	- All living organisms have certain common features which differentiate them from non-living entities - Stability in ecosystems result from interdependent relationships between organisms and their environment - Complex human interactions on varied scales may damage ecosystems	6-8 weeks	Formative · Daily lab activities and handouts · Group discussions & check-ins · Exit slip reflections · Online review games (Quizizz, Kahoot, Edulastic) Summative · Multiple Choice & Open Ended Quiz Common Benchmark Assessments (mid/end of course) · Final 'Themes in Biology' project Alternative Assessments (projects, etc when appropriate) · Group PBL assignment ○ Project Rubric ○ Presentation & Feedback
Goldilocks Planet: Earth's Cycles & You	- The unique interactions between Earth's spheres maintain the stable conditions needed to support all life - Matter and energy continually cycle through the living and nonliving components of our planet - Earth's natural cycles are being disrupted on a large scale by human activity	6-8 weeks	Formative · Daily lab activities and handouts · Group discussions & check-ins · Exit slip reflections · Online review games (Quizizz, Kahoot, Edulastic) Summative · Multiple Choice & Open Ended Quiz Common Benchmark Assessments (mid/end of course) · Final 'Themes in Biology' project

			Alternative Assessments (projects, etc when appropriate) · Group PBL assignment ○ Project Rubric ○ Presentation & Feedback
Cell Structures, Functions, and Disease	- Cells have specific structures to carry out their life functions on a microscopic scale, and work synergistically to maintain organismal survival - Cells combine to make tissues, which combine to make organs, which combine to make organ systems, which combine to make the organism - Diseases are caused by a disruption of the normal homeostatic functions within the body	6-8 weeks	Formative · Daily lab activities and handouts · Group discussions & check-ins · Exit slip reflections · Online review games (Quizizz, Kahoot, Edulastic) Summative · Multiple Choice & Open Ended Quiz Common Benchmark Assessments (mid/end of course) · Final 'Themes in Biology' project Alternative Assessments (projects, etc when appropriate) · Group PBL assignment ○ Project Rubric ○ Presentation & Feedback
The Story of You: DNA & Genetics	- The molecular structure of DNA encodes hereditary information and determines organismal traits through the process of protein synthesis - Genetic traits are passed from parents to offspring in predictable patterns - The advancement of genetic technologies will continue to impact society and raise ethical concerns	6-8 weeks	Formative · Daily lab activities and handouts · Group discussions & check-ins · Exit slip reflections · Online review games (Quizizz, Kahoot, Edulastic) Summative · Multiple Choice & Open Ended Quiz Common Benchmark Assessments (mid/end of course) · Final 'Themes in Biology' project Alternative Assessments (projects, etc when appropriate) · Group PBL assignment ○ Project Rubric ○ Presentation
The Family Tree of Life: Evolution and Natural Selection	- All living organisms are connected by shared ancestry through the process of evolution		Formative · Daily lab activities and handouts · Group discussions & check-ins · Exit slip reflections · Online review games (Quizizz, Kahoot, Edulastic)

	- Evidence for the process of evolution connects life at all levels, from the microscopic to the macroscopic		Summative · Multiple Choice & Open Ended Quiz Common Benchmark Assessments (mid/end of course) · Final 'Themes in Biology' project Alternative Assessments (projects, etc when appropriate) · Group PBL assignment ○ Project Rubric ○ Presentation

Unit #1- Networks of Life: Ecosystems & Biodiversity Loss

Instructional Time: Approximately 15 class periods

Stage 1 – Desired Results

Rationale:

This introductory unit of study begins by first exploring the distinguishing features and characteristics that separate living organisms from nonliving entities. This foundational understanding is of course critical for all subsequent explorations throughout the year and this unit, namely the macroscopic connections between organisms and ecosystems across the planet. Instead of beginning the course with a micro-level focus, which is not so readily observable and is therefore often more abstract and difficult to comprehend, the course will begin by examining observable biological interactions on a large scale, thereby appealing to the background knowledge and interests students often have about organisms. The theme of *stability and balance* is overtly emphasized, as students explore how complex interactions between populations of organisms in ecosystems maintain stable conditions across the planet; at the same time, these lessons reinforce that human lives do not exist in a vacuum but are rather intricately connected to all networks of life. Finally, students explore how human activities on a large scale are rapidly degrading this ecosystem stability, threatening the planet's biodiversity and our own survival.

Performance Expectations:

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. [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, or population changes gathered from simulations or historical data sets.]

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

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. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.

Possible Phenomena:

- Human Expansion & COVID-19: As human societies continue to expand in population and resource consumption globally, increased encroachment and destruction of natural ecosystems occurs. In many cases, this encroachment threatens not only the diversity of life in those ecosystems, but may even threaten human lives. One such example is the increased likelihood of human contact with zoonotic diseases, as is thought to have led to the global Covid-19 pandemic.
- Extinction events: Throughout the history of the planet, scientists have estimated that there have been at least five major extinction events caused by various natural factors. However, they now suggest we are in the sixth extinction event in which fifty percent of all species may be lost in the next century. Comparing the natural extinction events to the present 'anthropocene' or man-made extinction provides insight into factors related to the stability and change of ecosystems and loss of biodiversity.

Interdisciplinary Standards to be addressed:

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)

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)

ELA/Literacy-

RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6),(HS-LS2-7),(HS-LS2-8)

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS2-1),(HS-LS2-2),(HS-LS2-3),(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.9-12.7 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)

Visual Arts-

1.5.12acc.Cr3a Engage in constructive critique with peers, then reflect on, re- engage, revise, and refine works of art and design in response to personal artistic vision

Enduring Understandings / Big Ideas	**Problem(s) / Essential Questions**
Students will understand that: - All living organisms have certain common features, which differentiate them from non-living entities - Stability in ecosystems result from interdependent relationships between organisms and their environment - Complex human interactions on varied scales may damage ecosystems	● What makes you alive? ● Why are organism interactions critical to maintaining stable ecosystems? ● How are human lives connected to and impacting all life on the planet?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking ● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) ● Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)	**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. This fundamental tension affects the abundance (number of individuals) of	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8),(HS-LS4-6) **Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion,

● Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** ● Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7) **Engaging in Argument from Evidence** ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6) ● Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-8)	species in any given ecosystem. (HS-LS2-1),(HS-LS2-2) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2),(HS-LS2-6) ● Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (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 HS-LS2-7) ● Humans depend on the living world for the resources and other benefits provided by biodiversity.	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) **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)

Stage 2 – Assessment Evidence

Performance Tasks	**Other Evidence:**
● Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. ○ Students simulate the principles of predator-prey interactions as well as competition in game format to gather and graph data related to carrying capacity ○ Students analyze data, including finding averages and determining trends, about symbiotic relationships in various ecosystems ● Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. ○ See above ○ Students analyze data, including finding averages and determining trends, about population sizes in various ecosystems ● 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. ○ Students collect and evaluate simulated data on ecosystem interactions including symbiotic relationships, competition, and predation ○ Students create visual models of energy flow in ecosystems in the form of food chains and food webs ○ Students use online simulations to predict how ecosystem disruptions may affect organismal populations ● Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. ○ Students research and evaluate various solutions to halt biodiversity loss, connecting these solutions to organism	● Daily formative assessment should include use of do nows, exit tickets, and review games ○ Informal assessments conducted through Google Forms, Quizizz, Kahoot, Edulastic and other platforms in which teacher is able to give direct feedback and remediation to student understanding ○ Teacher will adjust subsequent lessons as needed based on this data ● Group-based lab & Peer Oriented Guided Inquiry Learning (POGIL) approaches will be employed in the vast majority of lessons ○ Whole class discussion will be employed to introduce collaborative learning tasks, and review them at the end ○ Teacher check-ins during collaborative group learning ● Individual formal assessment should include two quizzes (multiple choice and short answer) on: 1. Characteristics of Life and Biological Experimentation 2. Biomes, Ecosystems, and Organism Interactions

interactions learned throughout the unit A final performance assessment for this unit should include the following criteria: ○ Using mathematics & computational thinking and constructing explanations & designing solutions Suggested Performance Task that can meet the criteria: ● Biome Zoo Habitat Design ○ Research and collect information about organism interactions and abiotic conditions within a specific biome on the planet ○ Create a zoo habitat model of this biome, incorporating qualitative and quantitative demonstrations of how the habitat will maintain ecosystem balance ○ Rubric will be designed to correlate with performance expectations and will be differentiated based on the level of the class	

Stage 3 – Learning Plan

Learning Activities:

See activities & assessments mentioned above. On a daily basis, class will begin using some form of engagement hook, followed by a class discussion and introduction to key terms and concepts, then followed by a student-centered class engagement activity. The majority of class time will be dedicated to group-based and student centered lab/activity work. At the start, this first unit will begin with a general examination of the characteristics of life, with multiple introductory labs focused on identifying these characteristics and their importance to life. Subsequently, students will learn and model the principles of scientific experimentation in biology by conducting self-designed experiments. Next, the focus will shift to exploring the biomes of our planet, before zooming down to data analysis games and activities studying the population interaction patterns that exist in ecosystems and maintain stability. Finally, the negative impacts of large scale human actions will be explored.

Before and after all group activities, there will always be an introductory and concluding discussion. Students will be grouped into cooperative lab groups and allowed to explore tasks at their own pace. Differentiation will be based on student grouping and frequency of teacher guidance and assistance. Higher performing groups will be given less direct guidance and more opportunity to explore supplementary scenarios, while lower performing groups will be assisted more frequently and receive modified materials as needed.

Technology and the 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.

Know-What are the basics?:

- Characteristics of Life
- Scientific Method Basics (variable types, data types, etc.)
- Biomes & Ecosystems
- Organism Interactions (symbiosis, competition, predation, energy flow)
- Population Dynamics

How do I reinforce or build literacy or mathematics skills?

- Concept mapping
- KWL charts
- Venn Diagrams
- Composing CERs based on quantitative and qualitative data
- Generating and graphing quantitative data
- Predicting future trends based on current data
- Using quantitative data to create models

Unit #2- Goldilocks Planet: Earth's Cycles and You

Instructional Time: Approximately 15 class periods

Stage 1 – Desired Results

Rationale:

Having just explored the interactions between organisms that maintain ecosystem stability, the second unit now transitions to questioning how macroscopic matter and energy cycles connect living organisms not only to other organisms but also to the abiotic features of the entire planet. In this context, the second unit expands on the theme of balance to further incorporate a focus on the intrinsic connection between organisms and the planet itself. First, students must appreciate the unique 'Goldilocks' features of Earth which make it the only planet– certainly in our solar system but also potentially in our entire universe– that is suitable for sustaining life. Second, they must understand that these planetary cycles, such as the hydrologic and atmospheric cycles, have developed over billions of years to support life well before humans even existed. No life would possibly exist were it not for these constant matter and energy flows, which again involve interactions between life and the planet. The connection between photosynthesis and cellular respiration are of particular importance, especially within the context of Earth's carbon cycle. After increasing their knowledge on these various cycles and the unique features of Earth, students can finally explore how human population growth and excessive consumption are dramatically disrupting the planet, with an emphasis on the need for finding global solutions.

Performance Expectations:

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth. [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.]

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. [Clarification Statement: 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.]

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

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. [Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.]

HS-LS2-4. Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.]

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

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

Possible Phenomena:

- Exploring Mars: Throughout history, humans have been captivated by celestial objects. In modern times, our ability to not only study space, but also explore it, is rapidly increasing. Private companies are building rockets and NASA is already planning to send manned missions to Mars before the end of the 21st century, which raises many questions about the features of our planet. Why are humans suddenly so interested in exploring other planets? How do these planets compare to Earth? Can life not only survive but also thrive on these planets?

Interdisciplinary Standards to be addressed:

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)

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)

ELA/Literacy-

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-ESS2-2),(HS-ESS2-3)*

RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. *(HS-ESS2-2)*

WHST.9-12.1 Write arguments focused on *discipline-specific content.* (HS-ESS2-7)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-5)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-ESS2-2)*

Visual Arts-

1.5.12adv.Cr1a Visualize and generate art and design that can affect social change.

1.5.12adv.Cr2c Demonstrate in works of art or design how visual and material culture defines, shapes, enhances, inhibits, and/or empowers people's lives.

World Languages-

7.1.IH.IPRET.4 Summarize information from oral and written discourse dealing with a variety of topics.

7.1.IH.PRSNT.5 Express viewpoints on familiar and researched topics, give reasons to support the claims, and speak and write in strings of connected sentences and some short paragraphs.

7.1.IH.IPRET.8 Collect, share, and analyze data related to global issues including climate change.

Enduring Understandings / Big Ideas	Problem(s) / Essential Questions
Students will understand that: - The unique interactions between Earth's spheres maintain the stable conditions needed to support all life - Matter and energy continually cycle through the living and nonliving components of our planet - Earth's natural cycles are being disrupted on a large scale by human activity	• Is there life outside of our planet? • What properties and cycles of Earth allow it to sustain life? • How are human activities disrupting our planet's natural cycles?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1) • Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2) • Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6) **Constructing Explanations and Designing Solutions** • 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)(HS-LS2-3)	**LS1.C: Organization for Matter and Energy Flow in Organisms** • 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) • 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 and release energy to the surrounding environment and to maintain body temperature. Cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. (HS-LS1-7) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems**	**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** • 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),(HS-LS2-4) • Energy drives the cycling of matter within and between systems. (HS-LS2-3)

Developing and Using Models ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7) ● Develop a model based on evidence to illustrate the relationships between systems or components of a system.(HS-LS2-5)	● Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3) ● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans,and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **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 (HS-LS2-5)	

Stage 2 – Assessment Evidence

Performance Tasks	Other Evidence:
● Construct an argument based on evidence about the simultaneous coevolution of Earth systems and life on Earth. ○ Students analyze and graph data related to atmospheric gas composition throughout Earth's history. They subsequently create a timeline of major milestone events in Earth's biological history, examining connections between the two to construct an argument. ● Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. ○ Students perform online simulations exploring how photosynthesis is affected by various factors, such as light intensity, carbon dioxide levels, and wavelength of light. ● 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. ○ Students perform online simulations exploring the process of cellular respiration, modeling the connections between this process and photosynthesis. ● Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. ○ Students conduct a lab activity testing rates of cellular respiration at rest compared to during exercise. Data is used to make conclusions about the process of respiration. ● Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	● Daily formative assessment should include use of do nows, exit tickets, and review games ○ Informal assessments conducted through Google Forms, Quizizz, Kahoot, Edulastic and other platforms in which teacher is able to give direct feedback and remediation to student understanding ○ Teacher will adjust subsequent lessons as needed based on this data ● Group-based lab & Peer Oriented Guided Inquiry Learning (POGIL) approaches will be employed in the vast majority of lessons ○ Whole class discussion will be employed to introduce collaborative learning tasks, and review them at the end ○ Teacher check-ins during collaborative group learning ● Individual formal assessment should include at least one quiz (multiple choice and short answer) on Earth's spheres, major cycles, and the processes of photosynthesis & respiration

- Students analyze biomass data as presented in trophic pyramids for various ecosystems, supporting the claim that there is decreased energy and mass at higher trophic levels.

- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
  - Students perform online simulations exploring the carbon cycle, emphasizing the inverse reactions of photosynthesis and respiration, as well as how human activities are increasing levels of carbon throughout the planet.
  - Students work in groups to develop a flow chart connecting the four spheres of the planet.

- Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
  - Students use online simulations to analyze the Greenhouse Gas effect, comparing the natural levels of greenhouse gases in the atmosphere to the increased levels currently being emitted. They further analyze how increases in greenhouse gases may impact all spheres of the planet.

A final performance assessment for this unit should include the following criteria:

- Developing & using models, and constructing explanations & designing solutions

Suggested Performance Task that can meet the criteria:

- Protect our Planet Teaching Tool
  - Student groups develop a unique teaching tool (model) explaining the cycles of our planet and how human activities are threatening them

○ Students also propose and/or design realistic solutions to resolve these threats ○ Rubric will be designed to correlate with performance expectations and will be differentiated based on the level of the class	

Stage 3 – Learning Plan

Learning Activities:

See activities & assessments mentioned above. On a daily basis, class will begin using some form of engagement hook, followed by a class discussion and introduction to key terms and concepts, then followed by a student-centered class engagement activity. The majority of class time will be dedicated to group-based and student centered lab/activity work. In this second unit, the initial explorations will involve online simulations and data analysis activities to perform large-scale examinations of Earth's features in comparison to other planets, emphasizing the unique 'Goldilocks' conditions that exist on Earth. From here, students will transition to modeling activities that explore the spheres of Earth and how they are connected, before focusing on the carbon cycle in particular. This also includes modeling the processes of photosynthesis and cellular respiration, which place organisms in the carbon cycle. Finally, as in unit one, the negative impacts of human actions on the planet's cycles as a result of increased consumption and technological development– particularly increased greenhouse gas emissions and climate change– will be introduced through several online interactive activities and visualizations.

Before and after all group activities, there will always be an introductory and concluding discussion. Students will be grouped into cooperative lab groups and allowed to explore tasks at their own pace. Differentiation will be based on student grouping and frequency of teacher guidance and assistance. Higher performing groups will be given less direct guidance and more opportunity to explore supplementary scenarios, while lower performing groups will be assisted more frequently and receive modified materials as needed.

Technology and the Nature of Science:

Scientific Knowledge is Open to Revision in Light of New Evidence

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

Know-What are the basics?:

- Goldilocks Planet & Habitable Zone
- Earth's Spheres
- Biogeochemical Cycles (esp. Carbon Cycle)
- Photosynthesis

- Respiration
- Greenhouse Gases & Climate Change

How do I reinforce or build literacy or mathematics skills?

- Concept mapping
- KWL charts
- Venn Diagrams
- Composing CERs based on quantitative and qualitative data
- Generating and graphing quantitative data
- Predicting future trends based on current data
- Using quantitative data to create models

Unit #3- Cell Structures, Functions, and Disease

Instructional Time: Approximately 15 class periods

Stage 1 – Desired Results

Rationale:

Up to this point in the course, topics focused on examining the macroscopic interactions between biological organisms and the planet, with a particular emphasis on how humans impact the natural world. In the third unit, the same themes of balance and stability manifest on a much smaller scale, as students transition to exploring the biological interactions *within* any individual organism that sustain that individual organism's life. A new and critical biological theme called 'structure and function' forms the basis of this unit. It is essential that students realize and appreciate the level of complexity that exists at the cellular level within any complex organism. In humans, for example, trillions of cells, each with specific physical structures suiting their function, are continually able to coordinate the immensity of functions necessary to maintain homeostasis. These specific cells organize together to form specific tissues, which organize together to form specific organs, which organize together to form specific organ systems; the combination of all these systems finally results in the entire organism. Subsequently, any disruption of these structures and functions at any level in the hierarchy threatens the organism's ability to maintain homeostasis, resulting in various forms of disease. As such, the second half of the unit briefly explores the different categories of infection and non-infectious disease to enhance students' understanding of their own health, bolster their personal health choices, and increase their appreciation of the need for cooperation in addressing global public health concerns.

Performance Expectations:

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [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.]

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomata response to moisture and temperature, and root development in response to water levels.]

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

Possible Phenomena:

- Increasing Cancer Rates: Though the disease of cancer has affected people for thousands of years, statistics suggest the rates of cancer are rapidly and dramatically increasing in the modernized world. Some statistics suggest that up to one in three women and one in two men in the United States will be diagnosed with cancer in their lifetime. Cancer is a major disruption of the body's natural cellular structures and functions, and thus provides an ideal avenue through which to explore how the body's processes can be damaged by both environmental factors and personal choices.
- Global Pandemics: As previously mentioned in Unit 1, the Covid-19 pandemic offers incredible insight into the interconnections between people and ecosystems across the planet. In the context of cells and disease, it also acts as a perfect model for studying the unique qualities of infectious diseases, and can therefore act as a comparison point not only to previous pandemics but also to other large scale public health issues that may not be infectious.

Interdisciplinary Standards to be addressed:

Mathematics-

MP.2 Reason abstractly and quantitatively. (HS-LS2-1),(HS-LS2-2),(HS-LS2-4),(HS-LS2-6),(HS-LS2-7)

HSS-IC.B.6 Evaluate reports based on data. (HS-LS2-6)

ELA/Literacy-

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1),(HS-LS1-6)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1),(HS-LS1-6)

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-LS1-6)

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

WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)

SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)

World Languages-

7.1.IH.IPRET.4 Summarize information from oral and written discourse dealing with a variety of topics.

7.1.IH.PRSNT.5 Express viewpoints on familiar and researched topics, give reasons to support the claims, and speak and write in strings of connected sentences and some short paragraphs.

Visual Arts-

1.5.12adv.Cn10a Synthesize knowledge of social, cultural, historical, and personal life with artmaking approaches to create meaningful works of art or design.

Career Awareness and Planning-

9.2.12.CAP.4 Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment

- Students learn about different available careers in the life and health sciences, such as epidemiologists or oncologists, often taking on these careers as fictitious roles to solve problems.

Enduring Understandings / Big Ideas	**Problem(s) / Essential Questions**
Students will understand that: - Cells have specific structures to carry out their life functions on a microscopic scale, and work synergistically to maintain organismal survival - Cells combine to make tissues, which combine to make organs, which combine to make organ systems, which combine to make the organism - Diseases are caused by a disruption of the normal homeostatic functions within the body	● Why do different cells or body parts have different structures? ● How do cells work together to sustain life for an organism? ● What causes various diseases, and how can we avoid developing them?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations ● 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** ● 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-LS1-1) **Developing and Using Models** ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2),(HS-LS1-4) ● Develop a model based on evidence to illustrate the relationships between systems or components of a system.(HS-LS1-4)	**LS1.A: Structure and Function** ● Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) ● 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. (HS-LS1-1) ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) ● Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)	**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) **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) **Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

Stage 2 – Assessment Evidence

Performance Tasks	**Other Evidence:**
● 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. ○ Students will examine varied cell and tissue types under a microscope, using evidence to explain how each cell type has a specialized structure suited to its specific function. ○ Students will perform online and physical modeling activities to explain the role of various cell organelles in maintaining cellular life ○ In this unit, students will not focus on the role of DNA. ● Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. ○ See above ○ Students will design an organelle political campaign, highlighting the role of one specific cell organelle within the body's functions ● Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. ○ Students will plan and conduct both a virtual and laboratory investigation of how various factors such as ambient temperature and exercise rates impact homeostasis (heart rate and body temperature) ○ Students will conduct a case study investigating about human disorders related to malfunctioning cellular organelles ● Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. ○ Students will explore an online cell cycle interactive that models both the natural cycle in a healthy cell and an unhealthy cycle resulting in cancer	● Daily formative assessment should include use of do nows, exit tickets, and review games ○ Informal assessments conducted through Google Forms, Quizizz, Kahoot, Edulastic and other platforms in which teacher is able to give direct feedback and remediation to student understanding ○ Teacher will adjust subsequent lessons as needed based on this data ● Group-based lab & Peer Oriented Guided Inquiry Learning (POGIL) approaches will be employed in the vast majority of lessons ○ Whole class discussion will be employed to introduce collaborative learning tasks, and review them at the end ○ Teacher check-ins during collaborative group learning ● Individual formal assessment should include at least one quiz (multiple choice and short answer) on cellular organization, organelles, and the theme of structure and function in biological organisms

○ Students will model the process of mitosis by playing an interactive 'breakout' game, in which each stage of the cell cycle is represented A final performance assessment for this unit should include the following criteria: ○ Planning & carrying out investigations, developing & using models, and constructing explanations & designing solutions Suggested Performance Task that can meet the criteria: ● Cancer Case Study ○ Student groups research a unique form of cancer and its effects on the body's hierarchical systems ○ Students develop a case study about a fictitious patient with this form of cancer, and then take on the role of medical doctors diagnosis and treating the patient ○ Rubric will be designed to correlate with performance expectations and will be differentiated based on the level of the class	

Stage 3 – Learning Plan
Learning Activities: See activities & assessments mentioned above. On a daily basis, class will begin using some form of engagement hook, followed by a class discussion and introduction to key terms and concepts, then followed by a student-centered class engagement activity. The majority of class time will be dedicated to group-based and student centered lab/activity work. Unlike the previous units, this unit focuses extensively on individual organisms and the biological interactions happening within them, rather than around them. Therefore, the initial activities will introduce students to the theme of structure and function in biology, as they microscopically examine varied structures of different cell and tissue types. From here, students will 'zoom in' even more, using online interactive activities to explore the structures *within* cells that enable cellular life to exist and function properly. All of these activities emphasize that complex organisms are made of an immensely complicated network of cells functioning synergistically to ensure the maintenance of homeostasis. Finally, students will perform a series of case studies in which they take on the role of medical specialists, learning about how different categories of disease disrupt the human body's ability to function. Several documentaries on public health issues, such as viral epidemics and cancer, will also be used to increase student awareness of the importance of public health measures.

Before and after all group activities, there will always be an introductory and concluding discussion. Students will be grouped into cooperative lab groups and allowed to explore tasks at their own pace. Differentiation will be based on student grouping and frequency of teacher guidance and assistance. Higher performing groups will be given less direct guidance and more opportunity to explore supplementary scenarios, while lower performing groups will be assisted more frequently and receive modified materials as needed.

Technology and the 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.

Scientific Knowledge is Open to Revision in Light of New Evidence

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

Know-What are the basics?:

- Structure and Function
- Biological Organization (Cells→ Tissues→ Organs→ Organ Systems→ Organisms)
- Cellular Organelles
- Cell Cycle & Mitosis
- Homeostasis
- Categories of Disease

How do I reinforce or build literacy or mathematics skills?

- Concept mapping
- KWL charts
- Venn Diagrams
- Composing CERs based on quantitative and qualitative data
- Generating and graphing quantitative data
- Predicting future trends based on current data
- Using quantitative data to create models

Unit #4- The Story of You: DNA & Genetics

Instructional Time: Approximately 15 class periods

Stage 1 – Desired Results

Rationale:

At this point in the course, students have explored themes such as stability & balance as well as structure & function that connect life at both the macroscopic and microscopic level. Here, they will examine the smallest scale explored in this biology course, namely the microscopic structure known as DNA that encodes for hereditary traits in almost all organisms. The molecular language of DNA is a shared language linking every single organism on the planet, both currently and throughout life's history. No level in the hierarchical organization of life, ranging from cells to the entire biosphere, would exist were it not for this genetic molecule. Students must therefore first understand how to read and decode this genetic language, the same way our cells do; they will learn about DNA's unique structure and how it is decoded through protein synthesis to produce an enormous array of proteins that allow the body to function. Thereafter, they can also explore how this genetic code is passed from parents to offspring in predictable patterns that thus form the basis of heredity. Finally, as our understanding of genetics continues to rapidly advance, students must begin considering the ethical and societal implications of technologies such as genetic modification, genetic engineering, and cloning, technologies which are certain to impact our planet in the future.

Performance Expectations:

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

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

HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.]

HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.]

Possible Phenomena:

- Designer Babies & Cloning: At one point an idea only plausible in science-fiction, advancements in genetic technology theoretically will one day allow humans to 'design' their babies and choose what traits they prefer, or perhaps even perform human cloning. On the one hand, these technologies may benefit people by reducing the likelihood of genetic diseases, but they may also lead to unforeseen negative social consequences. Understanding the theoretical basis of these technologies and others like them first requires understanding the nature of DNA and its role in the body; perhaps more importantly, it also requires students to consider the potential ethical implications of genetic technologies in the future.

Interdisciplinary Standards to be addressed:

Mathematics -

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

HSS-IC.B.6 Evaluate reports based on data. (HS-LS3-3)

ELA/Literacy-

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

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

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

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-LS3-2)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS3-1)

World Languages-

7.1.IH.IPRET.4 Summarize information from oral and written discourse dealing with a variety of topics.

7.1.IH.PRSNT.5 Express viewpoints on familiar and researched topics, give reasons to support the claims, and speak and write in strings of connected sentences and some short paragraphs.

Career Awareness and Planning-

9.2.12.CAP.4 Evaluate different careers and develop various plans (e.g. costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment

- Students continue to learn about different available careers in the life and health sciences, such as genetic counselors, again taking on these careers as fictitious roles to solve problems.
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9.2.12.CAP.6: Identify transferable skills in career choices and design alternative career plans based on those skills.

- Students will gain valuable analytic, collaborative, and communicative skills throughout this unit, and will be encouraged to consider how these skills may manifest in their future careers.

Enduring Understandings / Big Ideas	**Problem(s) / Essential Questions**
Students will understand that: - The molecular structure of DNA encodes hereditary information and determines organismal traits through the process of protein synthesis - Genetic traits are passed from parents to offspring in predictable patterns - The advancement of genetic technologies will continue to impact society and raise ethical concerns	● Why do I look the way I do? ● How much of who I am is controlled by my genes? ● How might genetic technologies like cloning and genetic engineering impact our society?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems ● Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Developing and Using Models**	**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,which carry out most of the work of cells. (HS-LS1-1)	**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

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-1, HS-LS3-1)

Analyzing and Interpreting Data

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

Engaging in Argument from Evidence

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

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.A: Inheritance of Traits

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

LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (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, between systems at different scales. (HS-LS3-1)

Structure and Function

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

Cause and Effect

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

Scale, Proportion, and Quantity

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

	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)	

Stage 2 – Assessment Evidence	
Performance Tasks ● 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. ○ Students explore pre-made DNA models (on paper and online) before creating their own three-dimensional models of DNA Structure ○ Students perform a similar scaffolded learning process to model protein synthesis (transcription and translation) and construct explanations for how the process functions ● Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. ○ Students take on the role of genetic counselors advising fictitious expectant parents of a chromosomal abnormality their child may have ● Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations	**Other Evidence:** ● Daily formative assessment should include use of do nows, exit tickets, and review games ○ Informal assessments conducted through Google Forms, Quizizz, Kahoot, Edulastic and other platforms in which teacher is able to give direct feedback and remediation to student understanding ○ Teacher will adjust subsequent lessons as needed based on this data ● Group-based lab & Peer Oriented Guided Inquiry Learning (POGIL) approaches will be employed in the vast majority of lessons ○ Whole class discussion will be employed to introduce collaborative learning tasks, and review them at the end ○ Teacher check-ins during collaborative group learning ● Individual formal assessment should include at least two quizzes (multiple choice and short answer) on: 1. DNA Structure & Replication 2. Transcription and Translation 3. Genetic Inheritance Patterns

through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
    - Students solve several mutation mysteries, exploring how various genetic mutations affect the protein synthesis process

- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
    - Students survey peers in school to quantify and quantitatively analyze easily identifiable physical traits, and attempt to draw conclusions as to how those traits may be inherited
    - Students analyze and create genetic pedigrees for various patterns of genetic inheritance

A final performance assessment for this unit should include the following criteria:

- Developing & using models, and asking questions & defining problems

Suggested Performance Task that can meet the criteria:

- Genetic Story of You
    - Student groups attempt to create a genetic narrative of themselves incorporating both written narrative elements and genetic crosses
    - Students create a pedigree for their family tree as well as several Punnett squares demonstrating the potential inheritance patterns explaining their physiological traits
    - Rubric will be designed to correlate with performance expectations and will be differentiated based on the level of the class

Stage 3 – Learning Plan
Learning Activities: See activities & assessments mentioned above. On a daily basis, class will begin using some form of engagement hook, followed by a class

discussion and introduction to key terms and concepts, then followed by a student-centered class engagement activity. The majority of class time will be dedicated to group-based and student centered lab/activity work. The foundation for the fourth unit of the course is understanding the structure of DNA, which is an understanding that only truly developed as a result of scientific efforts in the previous century. Therefore, the initial modeling activities will introduce students to the basic structure of DNA in a scaffolded process, first having them explore pre-made paper and online models before constructing their own three-dimensional models. Likewise, a similar scaffolded modeling process will be used to explore the steps of protein synthesis, which takes the genetic message and translates it into proteins. At this point, students can then begin considering how genetic traits are passed from parents to offspring in predictable patterns that can be modeled using Punnett square practice problems. As an extension, the impacts of mutations in DNA and chromosomes will also be explored as students perform medical case studies about chromosomal abnormalities. Lastly, students will explore and reflect on topics such as cloning, genetic engineering, and designer babies by reading articles, and watching documentaries and movies about these issues.

Before and after all group activities, there will always be an introductory and concluding discussion. Students will be grouped into cooperative lab groups and allowed to explore tasks at their own pace. Differentiation will be based on student grouping and frequency of teacher guidance and assistance. Higher performing groups will be given less direct guidance and more opportunity to explore supplementary scenarios, while lower performing groups will be assisted more frequently and receive modified materials as needed.

Technology and the 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)

Know-What are the basics?:

- DNA Structure
- DNA Replication process
- Protein Synthesis (Transcription & Translation)
- Patterns of Genetic Inheritance (Mendelian & Non-Mendelian)
- Genetic Pedigrees

How do I reinforce or build literacy or mathematics skills?

- Concept mapping
- KWL charts
- Venn Diagrams
- Composing CERs based on quantitative and qualitative data
- Generating and graphing quantitative data
- Predicting future trends based on current data
- Using quantitative data to create models

Unit #5- The Family Tree of Life: Evolution and Natural Selection

Instructional Time: Approximately 15 class periods

Stage 1 – Desired Results

Rationale:

Having explored the systems and hierarchies that connect life at all levels, students are now ready to explore the shared family history linking them to all organisms on the planet. Indeed, biologists emphasize that evolution is the theme that permeates throughout all the different fields of biology and connects them all into a clear narrative. The principles of evolution, and in particular the concept of natural selection, form a cohesive framework through which we can understand how the immense biodiversity on our planet may have developed. In doing so, this framework explains how the variety of ecosystems on our planet have shaped the development of unique structures and functions in all organisms, which were passed on genetically through the language of DNA. Therefore, evolution is the connecting theme between the microscopic biological world– namely the language of DNA and the complex world of cellular organization– and the macroscopic biological world of organism interactions across massive ecosystems. A large portion of this unit must therefore focus on the evidence that exists for evolution, along with the principles underlying the process. More than just providing us with a framework for understanding the past however, evolutionary biology also has implications for us in the future. For example, students must consider how the processes of natural selection may lead to the microevolution of viruses and antibiotic resistant bacteria. Similarly, just as previous lifeforms faced extinction, it is essential to consider how human actions are forcing organisms to adapt or face extinction.

Performance Expectations:

HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.]

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

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

HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations. [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

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. [Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

Possible Phenomena:

- Antibiotic Resistant Bacteria: An interesting, observable, and extremely dangerous case of microevolution is the accidental development of antibiotic resistant bacteria strains such as MRSA. These strains kill thousands of people each year and perplex researchers who must look for new methods of combating them. When exposed to antibiotics, most bacteria die off. However, some bacteria by chance may have mutations which enable them to resist the effect of the antibiotics and therefore proliferate abundantly. As such, this phenomenon acts as an excellent example of the principles of natural selection and how they continue to impact us today.
- What Happened to Dinosaurs? (extinction events): From a young age, most children are fascinated by the imagery of dinosaurs they see in popular media and question why these organisms are no longer alive. Scientists estimate that there have been at least five major extinction events caused by various natural factors, each of which lead to a new chapter in the evolutionary history of life. However, they now suggest we are in the sixth extinction event in which fifty percent of all species may be lost in the next century. Comparing the natural extinction events to the present 'anthropocene' or man-made extinction provides insight into dramatic changes our planet has experienced in its history, as well as how these changes have dramatically altered the narrative of life.

Interdisciplinary Standards to be addressed:

Mathematics -

MP.2 Reason abstractly and quantitatively. *(HS-LS4-1)*,(HS-LS4-2),(HS-LS4-3),*(HS-LS4-4),(HS-LS4-5)*

MP.4 Model with mathematics. *(HS-LS4-2)*

ELA/Literacy -

RST-11.12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS4-1)*,(HS-LS4-2),*(HS-LS4-3)*,(HS-LS4-4)

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-LS4-5)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-LS4-1)*,(HS-LS4-2),*(HS-LS4-3)*,(HS-LS4-4)

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. *(HS-LS4-6)*

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. *(HS-LS4-6)*

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. *(HS-LS4-1)*,(HS-LS4-2),*(HS-LS4-3)*,(HS-LS4-4),(HS-LS4-5)

SL.11-12.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-LS4-1),(HS-LS4-2)*

Career Awareness and Planning-

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

- Students will be encouraged to decide if their postsecondary education plans will include pursuing the natural sciences. If so, they will be encouraged to begin taking steps towards achieving this goal, such as taking higher level science courses and volunteering.

Enduring Understandings / Big Ideas	Problem(s) / Essential Questions
Students will understand that: - All living organisms are connected by shared ancestry through the process of evolution - The evidence for the process of evolution connects life at all levels, from the microscopic to the macroscopic	● Why does Earth have so much biodiversity? ● What evidence is there for the theory of evolution?

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting 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) **Constructing Explanations and Designing Solutions** ● 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** ● Evaluate the evidence behind currently accepted explanations or solutions to	**LS4.A: Evidence of Common Ancestry and Diversity** ● Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1) **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	**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-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- LS4-3)

determine the merits of arguments. (HS-LS4-5) **Obtaining, Evaluating, and Communicating Information** ● 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)	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 andsexual 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) ● 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)	

Stage 2 – Assessment Evidence	
Performance Tasks: ● Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. ○ Students will evaluate various forms of evidence for evolution, including fossil and structural evidence, embryological evidence, and genetic evidence, and subsequently summarize this information ● 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. ○ Students will analyze data-based case studies of the microevolutionary process in organisms, to develop an explanation focused on how natural selection leads to the adaptation of organism populations ● 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. ○ Students will simulate the process of natural selection and collect data in a 'bean survival game', after which they will statistically analyze the data ○ Students will conduct an online simulation of birds experiencing macroevolution on an island, in which they	**Other Evidence:** ● Daily formative assessment should include use of do nows, exit tickets, and review games ○ Informal assessments conducted through Google Forms, Quizizz, Kahoot, Edulastic and other platforms in which teacher is able to give direct feedback and remediation to student understanding ○ Teacher will adjust subsequent lessons as needed based on this data ● Group-based lab & Peer Oriented Guided Inquiry Learning (POGIL) approaches will be employed in the vast majority of lessons ○ Whole class discussion will be employed to introduce collaborative learning tasks, and review them at the end ○ Teacher check-ins during collaborative group learning ● Individual formal assessment should include at least one quiz (multiple choice and short answer) on the evidence for evolution and principles of natural selection

collect and analyze data about the populations over a simulated million year time period

- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
    - Students will analyze data-analysis case studies of the microevolutionary process in organisms, to develop an explanation focused on how natural selection leads to the adaptation of organism populations
    - Students will conduct an online simulation of birds experiencing macroevolution on an island, in which they collect and analyze data over a simulated million year time period

- 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.
    - Students will explore the PBS Tree of Life activity to create phylogenetic trees demonstrating how organisms may be linked through common ancestry
    - Students will explore how speciation may occur by analyzing a macroevolution case study related to Galapagos Tortoises

A final performance assessment for this unit should include the following criteria:

- Engaging in argument from evidence, and obtaining, evaluating and communicating information

Suggested Performance Task that can meet the criteria:

- Evolutionary Tree of Life - Photo Project
    - Student groups take photographs both in nature and in their personal lives related to the theme of evolution

(evidence and principles) ○ For each photograph, they clearly communicate how the picture visualizes or represents a concept related evolution, citing the multiple lines of empirical evidence explored throughout the unit ○ Rubric will be designed to correlate with performance expectations and will be differentiated based on the level of the class	

Stage 3 – Learning Plan

Learning Activities:

See activities & assessments mentioned above. On a daily basis, class will begin using some form of engagement hook, followed by a class discussion and introduction to key terms and concepts, then followed by a student-centered class engagement activity. The majority of class time will be dedicated to group-based and student centered lab/activity work. Because evolution is an often contentious and misunderstood subject, significant learning time must be spent exploring the evidence for evolution and what it truly entails. Several introductory learning activities will therefore focus on introducing students to various lines of empirical evidence for evolution, such as fossil and structural evidence, embryological evidence, and genetic evidence. Next, students can perform various online simulations, modeling activities, and data analysis activities to explore the principles of natural selection that are the main driving force for evolutionary change. The activities will first focus on how microevolution occurs over small periods of time, before naturally extending to how macroevolution and speciation may occur in larger time periods. As a culmination, students can then explore online tools such as the PBS Tree of Life activity to create small-scale phylogenetic trees and gain insight into how evolutionary biologists explore the family history of life.

Before and after all group activities, there will always be an introductory and concluding discussion. Students will be grouped into cooperative lab groups and allowed to explore tasks at their own pace. Differentiation will be based on student grouping and frequency of teacher guidance and assistance. Higher performing groups will be given less direct guidance and more opportunity to explore supplementary scenarios, while lower performing groups will be assisted more frequently and receive modified materials as needed.

Technology and the 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)

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)

Know-What are the basics?:

- Evidence for Evolution (fossils, structures, embryological, genetic)
- Microevolution vs. Macroevolution
- Natural Selection
- Speciation & Extinction

How do I reinforce or build literacy or mathematics skills?

- Concept mapping
- KWL charts
- Venn Diagrams
- Composing CERs based on quantitative and qualitative data
- Generating and graphing quantitative data
- Predicting future trends based on current data
- Using quantitative data to create models

General Differentiated Instruction Strategies	
• Leveled texts • Chunking texts • Choice board • Socratic Seminar • Tiered Instruction • Small group instruction • Guided Reading • Sentence starters/frames • Writing scaffolds • Tangible items/pictures • Adjust length of assignment	• Repeat, reword directions • Brain breaks and movement breaks • Brief and concrete directions • Checklists for tasks • Graphic organizers • Assistive technology (spell check, voice to type) • Study guides • Tiered learning stations • Tiered questioning • Data-driven student partnerships • Extra time

Possible Additional Strategies for Special Education Students, 504 Students, At-Risk Students, and English Language Learners (ELLs)			
Time/General	**Processing**	**Comprehension**	**Recall**
• Extra time for assigned tasks • Adjust length of assignment • Timeline with due dates for reports and projects • Communication system between home and school • Provide lecture notes/outline	• Extra Response time • Have students verbalize steps • Repeat, clarify or reword directions • Mini-breaks between tasks • Provide a warning for transitions • Reading partners	• Precise step-by-step directions • Short manageable tasks • Brief and concrete directions • Provide immediate feedback • Small group instruction • Emphasize multi-sensory learning	• Teacher-made checklist • Use visual graphic organizers • Reference resources to promote independence • Visual and verbal reminders • Graphic organizers

Assistive Technology	Assessments and Grading	Behavior/Attention	Organization
• Computer/whiteboard • Tape recorder • Spell-checker • Audio-taped books	• Extended time • Study guides • Shortened tests • Read directions aloud	• Consistent daily structured routine • Simple and clear classroom rules • Frequent feedback	• Individual daily planner • Display a written agenda • Note-taking assistance • Color code materials

Enrichment

The goal of Enrichment is to provide learners with the opportunity to participate in extension activities that are differentiated and enhance the curriculum. All enrichment decisions will be based upon individual student needs.

- Show a high degree of intellectual, creative and/or artistic ability and demonstrate this ability in multiple ways.
- Pose questions and exhibit sincere curiosity about principles and how things work.
- The ability to grasp concepts and make real world and cross-curricular connections.
- Generate theories and hypotheses and pursue methods of inquiry.
- Produce products that express insight, creativity, and excellence.
- Possess exceptional leadership skills.
- Evaluate vocabulary
- Elevate Text Complexity
- Inquiry based assignments and projects
- Independent student options
- Tiered/Multi-level activities
- Purposeful Learning Center
- Open-ended activities and projects
- Form and build on learning communities
- Providing pupils with experiences outside the 'regular' curriculum
- Altering the pace the student uses to cover regular curriculum in order to explore topics of interest in greater depth/breadth within their own grade level
- A higher quality of work than the norm for the given age group.
- The promotion of a higher level of thinking and making connections.
- The inclusion of additional subject areas and/or activities (cross-curricular).
- Using supplementary materials in addition to the normal range of resources.

English Language Learner (ELL) Resources

- Learning style quiz for students- http://www.educationplanner.org/students/self-assessments/learning-styles-quiz.shtml
- "Word clouds" from text that you provide-http://www.wordle.net/
- Bilingual website for students, parents and educators: http://www.colorincolorado.org/
- Learn a language for FREE-www.Duolingo.com
- Time on task for students-http://www.online-stopwatch.com/
- Differentiation activities for students based on their Lexile-www.Mobymax.com
- WIDA-http://www.wida.us/
- Everything ESL - http://www.everythingESL.net
- ELL Tool Box Suggestion Site http://www.wallwisher.com/wall/elltoolbox
- Hope4Education - http://www.hope4education.com
- Learning the Language http://blogs.edweek.org/edweek/learning-the-language/
- FLENJ (Foreign Language Educators of NJ) 'E-Verse' wiki: http://www.flenj.org/Publications/?page=135
- OELA - http://www.ed.gov/offices/OBEMLA
- New Jersey Department of Education- Bilingual Education information http://www.state.nj.us/education/bilingual/

Special Education Resources

- Animoto -Animoto provides tools for making videos by using animation to pull together a series of images and combining with audio. Animoto videos or presentations are easy to publish and share. https://animoto.com
- Bookbuilder -Use this site to create, share, publish, and read digital books that engage and support diverse learners according to their individual needs, interests, and skills. http://bookbuilder.cast.org/
- CAST -CAST is a non-profit research and development organization dedicated to Universal Design for Learning (UDL). UDL research demonstrates that the challenge of diversity can and must be met by making curriculum flexible and responsive to learner differences. http://www.cast.org
- CoSketch -CoSketch is a multi-user online whiteboard designed to give you the ability to quickly visualize and share your ideas as images. http://www.cosketch.com/
- Crayon -The Crayon.net site offers an electronic template for students to create their own newspapers. The site allows you to bring multiple sources together, thus creating an individualized and customized newspaper. http://crayon.net/ Education Oasis -Education Oasis offers a collection of graphic organizers to help students organize and retain knowledge – cause and effect, character and story, compare and

contrast, and more! http://www.educationoasis.com/printables/graphic-organizers/

- Edutopia -A comprehensive website and online community that increases knowledge, sharing, and adoption of what works in K-12 education. We emphasize core strategies: project-based learning, comprehensive assessment, integrated studies, social and emotional learning, educational leadership and teacher development, and technology integration. http://www.edutopia.org/
- Glogster -Glogster allows you to create "interactive posters" to communicate ideas. Students can embed media links, sound, and video, and then share their posters with friends. http://edu.glogster.com/?ref=personal
- Interactives – Elements of a Story -This interactive breaks down the important elements of a story. Students go through the series of steps for constructing a story including: Setting, Characters, Sequence, Exposition, Conflict, Climax, and Resolution. http://www.learner.org/interactives/story/index.html
- National Writing Project (NWP) -Unique in breadth and scale, the NWP is a network of sites anchored at colleges and universities and serving teachers across disciplines and at all levels, early childhood through university. We provide professional development, develop resources, generate research, and act on knowledge to improve the teaching of writing and learning in schools and communities. http://www.nwp.org
- Pacecar -Vocab Ahead offers videos that give an active demonstration of vocabulary with audio repeating the pronunciation, definition, various uses, and synonyms. Students can also go through flash cards which give a written definition and visual representation of the word. http://pacecar.missingmethod.com/