EAST PENN SCHOOL DISTRICT

Biology
July 14, 2025

Unit 1 - Sustainability

STAGE 1 | DESIRED RESULTS
Context and relevance for student learning

Standards

3.4.9-12.D - Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope

3.4.9-12.A - Analyze and interpret how issues, trends, technologies, and policies impact agricultural, food, and environmental systems and resources.

3.4.9-12.G - Analyze and evaluate how best resource management practices and environmental laws achieve sustainability of natural resources.

Transfer

Students will be able to use their learning to independently...

- ☐ Engage in informed consumer practices and choices that take into account the impact on agricultural and environmental systems.
- ☐ Categorize, analyze, and interpret how humans and environmental systems relate and affect one another

Meaning

UNDERSTANDINGS
Students will understand that...

- ☐ Global access to resources varies widely across regions
- ☐ Sustaining a common resource likely involves trade-offs
- ☐ Best management practices and data driven resource management, as well as environmental laws and policies, encourage environmental sustainability.

ESSENTIAL QUESTIONS
Students will keep considering...

- ☐ How do actions and regulations support the equitable availability of resources for current and future generations?
- ☐ How do living things utilize natural resources in ways that impact agricultural and environmental systems?
- ☐ How do agricultural systems interact with environmental systems?

Acquisition(need to align with above and standards)

Students will know...

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- ☐ Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of

Students will be skilled at...

- ☐ Analyze and interpret real-world data that shows human impact on the environment
- ☐ Asking questions about the role of human actions on the environment and implications over time

	invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **Human Impacts on Earth Systems** ☐ The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. ***Ecosystem Dynamics, Functioning, and Resilience*** ☐ *A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.* ***Natural Resources*** ☐ *Resource availability has guided the development of human society.* **Key Vocabulary:** *sustainability*	☐ Analyze and interpret regional indicator data and assess patterns to determine effects of human actions on the environment ☐ Develop and use models to show how different human actions can affect sustainability

Unit 2 - Ecology

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.1.9-12.I (HS-LS2-1): Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

3.1.9-12.L (HS-LS2-2): Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem

3.1.9-12.J (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.

3.1.9-12.H (HS-LS2-4): Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere

3.1.9-12.K (HS-LS2-5): Use mathematical

Transfer

Students will be able to use their learning to independently...(make purpose-takeaway in 5 years)

- ❑ Evaluate evidence and apply scientific approaches to make informed decisions about complex environmental challenges, particularly those involving the interaction of natural and human-designed systems, such as managing natural resources for sustainability

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Ecosystems are complex systems that include both living (biotic) and non-living (abiotic) components that interact with each other.
- ☐ The cycling of matter and the flow of energy within ecosystems occur through interactions among different organisms and between organisms and the physical environment.
- ☐ As the environment and populations of species change, there are resulting changes in ecosystems.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ How do organisms interact with the living and nonliving environments to obtain matter and energy?
- ☐ How do matter and energy move through an ecosystem?
- ☐ How do environmental changes impact ecosystems?

Acquisition(need to align with above and standards)

Students will know...

LS2.A: Interdependent Relationships in Ecosystems

- ☐ Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Students will be skilled at...

- ☐ **Using Mathematical and Computational Thinking** to analyze ecological data. This includes using mathematical and/or computational representations to support explanations of factors affecting carrying capacity and to support claims for the cycling of matter and flow of energy in ecosystems. They will be skilled at performing quantitative analysis and comparison of factors affecting populations.
- ☐ **Analyzing and Interpreting Data** from ecological scenarios. Students will be able to analyze data using tools and mathematical models and evaluate the impact of new data on existing explanations or models of

representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **3.1.9-12.M (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. **3.1.9-12.N (HS-LS2-7):** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** - ☐ Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. ☐ Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4) ☐ Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ☐ A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience**	systems. They will be able to examine quantitative data to identify patterns in organism distribution. ☐ **Developing and Using Models** to represent ecological processes and systems. Students will be able to develop models based on evidence to illustrate relationships within and between systems, such as energy flow, matter cycling, and the carbon cycle. They will also be skilled at evaluating merits and limitations of different models. ☐ **Constructing Explanations** for ecological phenomena. They will be able to construct and revise explanations based on valid and reliable evidence about the cycling of matter and flow of energy in different conditions. This includes explaining how cellular processes like photosynthesis and cellular respiration drive matter cycling and energy flow. ☐ **Engaging in Argument from Evidence** about ecological claims and solutions. Students will be able to make and defend claims based on evidence about the natural world. They will be skilled at evaluating the claims, evidence, and reasoning behind explanations or solutions regarding ecosystem stability and sustainable practices. They will also be able to compare and evaluate competing arguments or design solutions. ☐ **Obtaining, Evaluating, and Communicating Information** about ecosystems. This involves critically reading scientific literature to determine central ideas and obtain technical information. They will be skilled at obtaining information about disruptions and impacts in ecosystems from various sources. ☐ **Designing Solutions** for environmental problems. Students will be able to design, evaluate, and refine solutions for reducing

	☐ 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. **LS4.D: Biodiversity and Humans** ☐ Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary) ☐ Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. **Key Vocabulary:** *abiotic, aerobic respiration, anaerobic respiration, atmosphere, biodiversity, biotic, biosphere, carbon cycle, carrying capacity, cellular respiration, competition, ecological relationships, ecosystem, energy transfer, geosphere, human disturbances, hydrosphere, limiting factors, niche, organism, photosynthesis, population, predation, proportion, respiration, scale, succession*	the impacts of human activities on the environment and biodiversity. This includes defining criteria and constraints for solutions, evaluating solutions based on evidence and trade-offs, and considering various impacts (economic, social, environmental). ☐ **Applying Concepts of Cause and Effect** to understand how factors influence population changes and ecosystem disruptions. ☐ **Applying Concepts of Stability and Change** to analyze how ecosystems respond to changing conditions or disturbances ☐ **Applying Concepts of Systems and System Models** to understand ecosystems as interconnected components and model flows within them

Unit 3 - Cells

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.1.9-12.A (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.

3.1.9-12.B (HS-LS1-2): Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

3.1.9-12.C (HS-LS1-3): Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

3.1.9-12.E (HS-LS1-5): Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

3.1.9-12.F (HS-LS1-6): Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may

Transfer

Students will be able to use their learning to independently...(make purpose-takeaway in 5 years)

- ❏ Understand and contribute to addressing complex, interconnected global health challenges by applying their knowledge of how biological systems function and are affected by environmental and societal changes.

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Organisms have characteristic structures which enable functions and behaviors that allow them to grow, reproduce, and die.
- ☐ The structures, functions, and behaviors of organisms allow them to obtain, use, transport, and remove the matter and energy needed to live.
- ☐ The cycling of matter and the flow of energy within ecosystems occur through interactions among different organisms and between organisms and the physical environment.
- ☐ As the environment and populations of species change, there are resulting changes in ecosystems

ESSENTIAL QUESTIONS

Students will keep considering...

- ❏ How do the structures of organisms enable life's functions?
- ❏ How do organisms obtain and use the matter and energy they need to live and grow?
- ❏ How do matter and energy move through an ecosystem?
- ❏ How do environmental changes impact ecosystems?

Acquisition(need to align with above and standards)

Students will know...

<u>LS1.A: Structure and Function</u>

- ☐ 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

Students will be skilled at...

- ☐ **Constructing Explanations based on evidence** about how biological processes (like energy flow, molecular function, and homeostasis) function and how environmental or societal changes can cause disruptions or disease.

combine with other elements to form amino acids and/or other large carbon-based molecules. **3.1.9-12.G (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. **3.1.9-12.J (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. **3.1.9-12.N (HS-LS2-7):** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	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) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) ☐ 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) **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) ☐ The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6) ☐ As matter and energy flow through different organizational levels of living systems, chemical elements are	☐ **Developing and Using Biological Models** to represent complex biological structures (like cells and body systems), their hierarchical organization, and the flow of energy and matter within these systems. ☐ **Planning and Carrying Out Investigations** to collect data about biological phenomena relevant to the unit, such as cell responses to conditions or cellular respiration. ☐ **Analyzing and Interpreting Biological Data** from investigations, case studies, and other sources to understand biological systems, health issues (like disease), and the effects of disruptions. ☐ **Designing Solutions** for complex global health and environmental challenges by applying scientific understanding of cells, body systems, and homeostasis, and developing, evaluating, and refining potential solutions. ☐ **Using Mathematics and Computational Thinking** to analyze biological data, interpret system relationships, and support scientific understanding of biological phenomena relevant to cells, diseases, homeostasis, and global health challenges. ☐ **Obtaining, Evaluating, and Communicating Scientific Information** by researching, critically assessing, and effectively presenting scientific data and findings about cells, diseases, homeostasis, and global health challenges from diverse sources. ☐ **Engaging in Argument from Evidence** by constructing and defending scientific arguments to support claims about biological processes, system disruptions (including disease), and the effectiveness of solutions. ☐ **Applying Systems Thinking** to analyze biological and health phenomena (like homeostasis and disease) as interconnected

	recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) ☐ As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7) **Key Vocabulary:** *ADP/ATP, amino acid, chemical energy, cellular respiration, circulatory system, DNA, DNA replication, eukaryotic, excretory system, feedback loops, food molecule, genes, glucose, homeostasis, hydrocarbon, input, levels of biological organization, light energy, macromolecules, matter, metabolism, mitochondria, model, molecules, monomer, multicellular, net transfer, nutrient, organism,, organic, organ, organ system, osmoregulation, output, output, photosynthesis, polymer, product, products, prokaryotic, protein, protein, protein synthesis, reactant, reactants, regulation, RNA, stimuli, stored energy, stomate, system, temperature, tissue, transcription, translation, transpiration, unicellular*	systems, understanding interactions, stability, and responses to change at different levels of biological organization (cellular to organismal).

Unit 4 - Genetics

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.1.9-12.A (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.

3.1.9-12.D (HS-LS1-4): Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

3.1.9-12.N (HS-LS2-7): Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

3.1.9-12.P (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.

3.1.9-12.Q (HS-LS3-2): Make and defend a claim based on evidence that inheritable genetic variations may result

Transfer

Students will be able to use their learning to independently...(make purpose-takeaway in 5 years)

- ❏ Understand and engage with complex issues at the intersection of genetics, technology, society, and the environment

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ Organisms have characteristic structures which enable functions and behaviors that allow them to grow, reproduce, and die.
- ☐ The characteristic structures, functions and behaviors of organisms change in predictable ways as they progress through their life cycle.
- ☐ As the environment and populations of species change, there are resulting changes in ecosystems
- ☐ Offspring resemble, but are not identical to, their parents due to traits being passed from one generation to the next via genes.
- ☐ Variation among individuals of the same species can be explained by both genetic and environmental factors.

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ How do the structures of organisms enable life's functions?
- ☐ How do organisms grow and develop?
- ☐ How do environmental changes impact ecosystems?
- ☐ How are the characteristics of one generation related to the previous generation?
- ☐ Why do individuals of the same species vary in how they look, function, and behave?

Acquisition(need to align with above and standards)

Students will know...

LS1.A: Structure and Function

- ☐ Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

Students will be skilled at...

- ☐ **Developing and using models** to illustrate biological processes such as mitosis, cell differentiation, gene expression, meiosis, and genetic modification.

from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. **3.1.9-12.R (HS-LS3-3):** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	☐ 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) (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.) **LS1.B: Growth and Development of Organisms** ☐ In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ☐ Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **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)	☐ **Constructing Explanations and Designing Solutions**: Students build explanations for phenomena like how genetic modification results in new traits, how proteins are made from DNA, and how herbicide resistance develops. ☐ **Developing and Using Models**: Students create and use models to illustrate biological processes such as mitosis, cell differentiation, gene expression, meiosis, and genetic modification. ☐ **Asking Questions and Defining Problems**: Students formulate questions to understand and clarify relationships related to the role of DNA and chromosomes in inheritance, how genes influence traits, and the processes of protein synthesis and genetic modification. ☐ **Analyzing and Interpreting Data**: Students examine and make sense of various types of data, including analyzing data from genetic crosses using Punnett squares, interpreting data related to the spread of herbicide-resistant weeds, analyzing data from scientific studies on GMOs, and analyzing data about biodiversity. ☐ **Engaging in Argument from Evidence:** Students make and defend claims using evidence about the causes of inheritable genetic variations and other scientific ideas. ☐ **Obtaining, Evaluating, and Communicating Information**: Students gather information from multiple sources about topics like genetic modification and GMOs. ☐ **Using Mathematics and Computational Thinking:** Students apply mathematical concepts, particularly probability and statistics, to explain patterns of inheritance and the distribution of traits in populations.

	LS3.B: Variation of Traits ☐ In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) ☐ Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3) **Key Vocabulary**: *allele, biodiversity, chromosome, differentiation, DNA, DNA replication, ecosystem, gene, gene expression, genetic mutation, genetic variation, genes, human, inheritance, input, meiosis, mitosis, model, multicellular differentiation, organism, organ, organ system, output, protein, protein synthesis, RNA, system, tissue, traits, transcription, translation*	

Unit 5 - Evolution

STAGE 1 | DESIRED RESULTS

Context and relevance for student learning

Standards

3.1.9-12.N (HS-LS2-7): Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

3.1.9-12.O (HS-LS2-8): Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

3.1.9-12.S (HS-LS4-1): Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

3.1.9-12.T (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

Transfer

Students will be able to use their learning to independently...(make purpose-takeaway in 5 years)

- ☐ Approach new ecological and environmental challenges with the foundational knowledge of how ecosystems function, the skills to analyze data and develop models, and the capacity to evaluate information and design potential solutions

Meaning

UNDERSTANDINGS

Students will understand that...

- ☐ As the environment and populations of species change, there are resulting changes in ecosystems
- ☐ Many species live in groups, increasing the chances of survival for individuals and their relatives
- ☐ Comparison between species provides evidence that they evolved from common ancestors, explaining the similarities and differences between species.
- ☐ In any environment, individuals with particular traits may be more likely than others to survive and produce offspring.
- ☐ When the environment changes, some individuals in a population may have traits that provide a reproductive advantage which over many generations can change the make-up of a population

ESSENTIAL QUESTIONS

Students will keep considering...

- ☐ How do environmental changes impact ecosystems?
- ☐ How do organisms interact in groups so as to benefit individuals?
- ☐ What evidence supports the relationship between species?
- ☐ How does genetic variation among organisms affect survival and reproduction?
- ☐ How does the environment influence populations of organisms over multiple generations?
- ☐

Acquisition(need to align with above and standards)

Students will know...

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- ☐ Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction,

Students will be skilled at...

- ☐ **Analyzing and interpreting data** from various sources (such as fossil records or simulations) to identify patterns that provide evidence for evolution, the diversity of life, extinction events, changes in life

able to survive and reproduce in the environment. **3.1.9-12.U (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. **3.1.9-12.W (HS-LS4-4):** Construct an explanation based on evidence for how natural selection leads to adaptation of populations. **3.1.9-12.X (HS-LS 4-5):** 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. **3.1.9-12.V (HS-LS4-6):** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7) **LS2.D - Social Interactions and Group Behavior** ☐ Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8) **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 more common in the population. (HS-LS4-3) ☐ 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	forms over time, or the effects of resource availability. This includes understanding historical changes documented by fossils and analyzing the diversity of life in different habitats. ☐ **Constructing evidence-based explanations** for fundamental evolutionary processes. This includes explaining how natural selection leads to adaptation of populations and describing how evolution results from factors like the potential for population growth, heritable genetic variation, resource competition, and differential survival and reproduction. ☐ **Communicating scientific information** to explain how multiple lines of empirical evidence (such as fossil records, anatomical similarities, DNA sequences) support the theory of common ancestry and biological evolution. ☐ **Applying concepts of statistics and probability** to support explanations of evolutionary phenomena. Specifically, students should be able to use these concepts to explain why organisms with advantageous heritable traits tend to increase in proportion within a population over time. ☐ **Evaluating evidence that supports claims** about how changes in environmental conditions can affect species. This includes understanding how such changes can lead to increases in some species, the emergence of new species, or the extinction of others, and how environmental changes impact organisms (some survive, some move, some die). ☐ **Designing, evaluating, and refining solutions to complex real-world problems**, particularly those focused on reducing the negative impacts of human activities on the environment and biodiversity. This involves

	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) ☐ Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. (HS-LS4-5),(HS-LS4-6) ☐ Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5) **Key Vocabulary:** *adaptation, allele frequency, biological, biological fitness, biodiversity, competition, convergent evolution, divergent evolution, evidence evolution, evolutionary, extinction, genetic variation, human disturbances, mutation, natural selection, speciation, species*	considering prioritized criteria and trade-offs like cost, safety, and environmental impact. ☐ **Using computer simulations** to model and test aspects of evolution or the impact of proposed solutions. This allows students to explore the effects of human activities on biodiversity or model proposed solutions to mitigate adverse impacts. ☐ **Engaging in evidence-based arguments** about scientific claims related to evolution and biodiversity. This includes evaluating evidence for claims such as the role of group behavior on survival or whether human activity is causing a major extinction event. ☐ **Obtaining and evaluating scientific information** from diverse sources to understand core ideas about biological evolution, common ancestry, and human impact on life on Earth. ☐ Connecting inheritance, variation, and the process of natural selection. Students should grasp that different organisms have different inherited traits, that the environment affects traits, and that variations can provide survival advantages, leading to differential survival and reproduction.