Chino Valley Unified School District
High School Course Description

A. CONTACTS	
1. School/District Information:	School/District: Chino Valley Unified School District Street Address: 5130 Riverside Dr., Chino, CA 91710 Phone: (909) 628-1201 Web Site: chino.k12.ca.us
2. Course Contact:	Teacher Contact: Office of Secondary Curriculum Position/Title: Director of Secondary Curriculum Site: District Office Phone: (909) 628-1201 X1630

B. COVER PAGE - COURSE ID	
1. Course Title:	Biology and the Living Earth Honors
2. Transcript Title/Abbreviation:	Bio and Living Earth H
3. Transcript Course Code/Number:	5S02
4. Seeking Honors Distinction:	No
5. Subject Area/Category:	Meets the UC/CSU “d” Laboratory Science requirement
6. Grade Level(s):	9-12
7. Unit Value:	5 credits per semester/10 credits total
8. Course Previously Approved by UC:	No
9. Classified as a Career Technical Education Course:	No
10. Modeled after an UC-approved course:	Yes
11. Repeatable for Credit:	No
12. Date of Board Approval:	May 3, 2018 / March 3, 2022

13. Brief Course Description:
Biology and the Living Earth Honors emphasizes an understanding with depth and complexity of the nature of living things, their environment, and their relationships with man.

14. Prerequisites:	Co-requisite: Integrated Math 1 or Higher

15. Context for Course:
Biology and the Living Earth is one of three courses in California’s three-course model for high schools implementing NGSS. To highlight the nature of Earth and space sciences (ESS) as an interdisciplinary pursuit the course presents an integration of ESS and Biology. The honors course in Biology is distinguished by the depth and scope of work required to show mastery of the skills with increased rigor and complexity beyond the scope of a general course.

16. History of Course Development:
The course was developed to meet the 2013 state adopted NGSS standards for the advanced learner. It is one course from a three-course model that combines all high school performance expectations into three courses.

17. Textbooks:	Savvas Learning Company LLC. *Experience Biology The Living Earth.* Miller, Levine. 9th – 12th Grade. 2020
18. Supplemental Instructional Materials:	Teacher-created materials, as needed

C. COURSE CONTENT

1. Course Purpose:
The Biology and the Living Earth course, based on the Next Generation Science Standards, explores relationships between the living and nonliving components of Earth’s systems. By using science and engineering practices, cross-cutting disciplinary concepts, and evidence from experiments, research, and observations, students will learn how to formulate questions, evaluate claims, and develop models to make interpretations and investigate the natural world. The Sequence of Units are as followed: Ecosystems Interactions and Energy, Structure, Function, and Growth (from

organisms to cells), History of Earth's Atmosphere (Photosynthesis and Respiration), Evidence of Evolution, Inheritance of Traits, and Ecosystem Stability and the Response to Climate Change.

2. Course Outline:

Unit 1: Ecosystems Interactions & Energy (Intro Earth systems thru organisms): Students use mathematical and computer models to determine the factors that affect the size and diversity of populations in ecosystems, including the availability of resources and interactions between organisms.

Guiding Questions:

- What factors affect the size of populations within an ecosystem?
- What are common threats to remaining natural ecosystems and biodiversity? How can these threats be reduced?

Learning Targets:

- Students will use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- Students will use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Students will use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- Students will evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

NGSS Three Dimensions:

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.D: Social Interactions and Group Behavior

Science and Engineering Practices

- SEP-2: Developing and Using Models
- SEP-3: Planning and Carrying Out Investigations
- SEP-4: Analyzing and Interpreting Data
- SEP-5: Using Mathematics and Computational Thinking
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-8: Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

- CCC-2: Cause and Effect
- CCC-3: Scale, Proportion, and Quantity
- CCC-4: System and System Models
- CCC-5: Energy and Matter: Flows, Cycles, and Conservation

Highlighted California Environmental Principles & Concepts:

- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Common Core:

- CA CCSS Math Connections: N-Q.1-3; S-ID.1; S-IC.1,6; MP.2, MP.4
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: RST.9-10.8; RST.11-12.1,7,8; WHST.9- 12.2a-e

Unit 2: Structure, Function & Growth (organisms to cells): Students use models to create explanations of how cells use DNA to construct proteins, build biomass, reproduce, and create complex multicellular organisms. They investigate how these organisms maintain stability.

Guiding Questions:

- What happens if a cell in our body dies?
- How does the structure of DNA affect how cells look and behave?
- How do systems work in a multi-celled organism (emergent properties) and what happens if there is a change in the system?
- How do organisms survive even when there are changes in their environment?

Learning Targets:

- Students will 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 develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- Students will plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- Students will use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
- Students will construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

NGSS Three Dimensions:

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas

- LS1.B: Growth and Development of Organisms
- LS1.A: Structure and Function
- ETS1.C: Optimizing the Design Solution

Science and Engineering Practices

- SEP-2: Developing and Using Models
- SEP-3: Planning and Carrying Out Investigations
- SEP-4: Analyzing and Interpreting Data
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-7: Engaging in Argument from Evidence
- SEP-8: Obtaining, Evaluating, and Communicating

Crosscutting Concepts

- CCC-1: Patterns
- CCC-2: Cause and Effect
- CCC-3: Scale, Proportion, and Quantity
- CCC-4: System and System Models
- CCC-6: Structure and Function
- CCC-7: Stability and Change

Common Core:

- CA CCSS Math Connections: F-IF.7.a-e; F-BF.1a-c; MP.2; MP.4
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: RST.11-12.1,8, WHST.9-12.2.a-e, 7,9

Unit 3: History of Earth's Atmosphere (Photosynthesis & Respiration, Earth's atmosphere): Students make a model that links photosynthesis and respiration in organisms to cycles of energy and matter in the Earth system. They gather evidence about the linked history of Earth's biosphere and atmosphere.

Guiding Questions:

- How do living things acquire energy and matter for life?
- How do organisms store energy?
- How are photosynthesis and cellular respiration connected?
- How do organisms use the raw materials they ingest from the environment?
- How has the cycling of energy and matter changed over Earth's history?

Learning Targets:

- Students will use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- Students will construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
- Students will 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 will construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- Students will 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 will apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
- Students will develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
- Students will construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
- Students will use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- Students will plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

NGSS Three Dimensions:

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms

Science and Engineering Practices

- SEP-2: Developing and Using Models
- SEP-3: Planning and Carrying Out Investigations
- SEP-4: Analyzing and Interpreting Data
- SEP-5: Using Mathematics and Computational Thinking
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-7: Engaging in Argument from Evidence
- SEP-8: Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

- CCC-1: Patterns

- CCC-3: Scale, Proportion, and Quantity [CCC-6] Structure and Function
- CCC-7: Stability and Change

Highlighted California Environmental Principles & Concepts:

- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from and can alter.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Principle V: Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

Common Core:

- CA CCSS Math Connections: MP.2; MP.4
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: SL.11-12.4; RST.11-12.1,8, WHST.9- 12.2.a-e, 7,9

Unit 4: Evidence of Evolution: Students develop a model about how rock layers record evidence of evolution as fossils. Building on their learning from previous grades, they focus on effectively communicating this evidence and relate it to principles of natural selection.

Guiding Questions:

- How do layers of rock form and how do they contain fossils?
- Why do we see fossils across the world from each other but living organisms that are very different from each other?
- What evidence shows that different species are related?
- How did modern day humans evolve?

Learning Targets:

- Students will communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
- Students will 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 construct an explanation based on evidence for how natural selection leads to adaptation of populations.
- Students will 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 evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
- Students will plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- Students will construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Students will evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

- Students will use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- Students will evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

NGSS Three Dimension

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas
- LS1.B: Growth and Development of Organisms
- LS3.A: Inheritance of Traits
- LS3.B: Variation of Traits
- LS4.B: Natural Selection

Science and Engineering Practices
- SEP-1: Asking Questions and Defining Problems
- SEP-2: Developing and Using Models
- SEP-4: Analyzing and Interpreting Data
- SEP-5: Using mathematics and Computational Thinking
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-7: Engaging in Argument from Evidence
- SEP-8: Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts
- CCC-3: Scale, Proportion, and Quantity

Highlighted California Environmental Principles & Concepts:
- <u>Principle I:</u> The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- <u>Principle II:</u> The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.
- <u>Principle III:</u> Natural systems proceed through cycles that humans depend upon, benefit from and can alter.
- <u>Principle IV:</u> The exchange of matter between natural systems and human societies affects the long- term functioning of both.

Common Core:
- CA CCSS Math Connections: MP.2; MP.4
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: RST.11-12.1,9, WHST.9-12.1.a-e, 2.a-e, 7,9

Unit 4: Inheritance of Traits: Students develop explanations about the specific mechanisms that enable parents to pass traits on to their offspring. They make claims about which processes give rise to variation in deoxyribonucleic acid (DNA) codes and calculate the probability that offspring will inherit traits from their parents.

Guiding Questions:
- How are characteristics of one generation passed to the next?
- What allows traits to be transmitted from parents to offspring?
- How does variation affect a population under selective pressures?

Learning Targets:
- Students will 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 will 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.
- Students will apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
- Students will 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 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 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.

NGSS Three Dimension

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas

- LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection
- LS4.C: Adaptation
- ESS1.C: The History of Planet Earth
- ESS2.C: The Roles of Water in Earth's Surface Processes

Science and Engineering Practices

- SEP-2: Developing and Using Models
- SEP-3: Planning and Carrying Out Investigations
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-7: Engaging in Argument from Evidence
- SEP-8: Obtaining, Evaluating, and Communicating Information

Crosscutting Concepts

- CCC-1: Patterns [CCC-2] Cause and Effect[CCC-4] System and System Models
- CCC-5: Energy and Matter: Flows, Cycles, and Conservation [CCC-7] Stability and Change

Highlighted California Environmental Principles & Concepts:

- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from and can alter.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Common Core:

- CA CCSS Math Connections: N-Q.1-3; F.IF.5; S-ID.6.a-c; MP.2, MP.4
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: SL.11-12.5; RST.11-12.1, WHST.9-12.2a-e, 5,8,9

Unit 6: Ecosystems Stability: Students use computer models to investigate how Earth's systems respond to changes, including climate change. They make specific forecasts and design solutions to mitigate the impacts of these changes on the biosphere.

Guiding Questions:

- What effects changes in ecosystems that ultimately effect populations?
- What are the changes that are happening in the climate and what effects are those having on life?
- How are human activities impacting Earth's systems and how does that affect life on Earth?

- What can humans do to mitigate their negative impact on the environment?

Learning Targets:

- Students will 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 will design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- Students will 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 create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- Students will create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- Students will evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Students will analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Students will use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- Students will analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- Students will design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Students will evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- Students will use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

NGSS Three Dimensions:

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Disciplinary Core Ideas

- LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS4.C: Adaptation
- LS4.D: Biodiversity and Humans
- ESS3.D: Global Climate Change

Science and Engineering Practices

- SEP-1: Asking Questions and Defining Problems
- SEP-2: Developing and Using Models
- SEP-4: Analyzing and Interpreting Data
- SEP-6: Constructing Explanations (for science) and Designing Solutions (for engineering)
- SEP-7: Engaging in Argument from Evidence
- SEP-8: Obtaining, Evaluating, and Communicating Information]

Crosscutting Concepts

- CCC-1: Patterns
- CCC-3: Scale, Proportion, and Quantity [CCC-4] System and System Models [CCC-7] Stability and Change

Highlighted California Environmental Principles & Concepts:
- Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.
- Principle III: Natural systems proceed through cycles that humans depend upon, benefit from and can alter.
- Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Principle V: Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

Common Core:
- CA CCSS Math Connections: MP.2; N-Q.1-3; S-ID.1; S-IC.1,6
- CA ELD Connections: ELD.PI.11-12.1,5,6a-b,9,10,11a
- CA CCSS ELA/Literacy Connections: RST.9-10.8; RST.11-12.1,2,7,8; WHST.9- 12.2.a-e, 7,8.9

Nest Generation Science Standards

Earth and Space Science:

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).] (Introduced, but assessed in High School Chemistry in the Earth System course)

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's 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.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.* [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.] (Introduced but not fully assessed until IS6)

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.* [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.* [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

Engineering, Technology and Applications of Science:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Life Science:

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. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

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. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.]

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.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

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, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]

HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]

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.] [Assessment Boundary: Assessment does not include specific biochemical steps.]

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]

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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.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

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, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

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.] [Assessment Boundary: Assessment is limited to provided data.]

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.] [Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.]

HS-LS2-4. Use mathematical representations 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.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]

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.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]

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-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]

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. [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

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.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

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.] [Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.]

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 number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

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behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

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.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

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.]

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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.]

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3. Key Assignments:

Unit 1: Interactive Population Dynamics: Students determine where mice, rabbits, foxes, and owls fit into a food chain. The classroom is set-up to present a various number of these animals are posted; students calculate the population density of each organism, then evaluate the effect of density-dependent and density-independent limiting factors.

Unit 2: Life is in the Blood: Evaluate how multiple human body systems maintain homeostasis in am multicellular organism focusing on the transfer of material through the circulatory system via blood cells. Instructional strategies used are using visuals to model the systems, small group collaborative research, and presentation.

Unit 3: Floating Leaf Disk: An inquiry lab opportunity for students to collect and record the number of floating disks under different treatments. Using the collected data, students model the results in a graph to indicate the rate of photosynthesis. As photosynthesis occurs oxygen is released inside the leaf causing the disks to rise, however, different variables can be manipulated (color or light, light intensity, type of leaf, water temperature, CO2 concentration, etc.)

Unit 4: It's not Fair: Modeling how mutations contribute to natural selection, based on traits and random environmental factors. Students choose traits each round with potential to be beneficial or harmful; it's a visual representation of evolution (change of organism throughout the rounds).

Unit 5: Super Baby Genetics: Connecting concepts of co-dominance, multiple alleles, Punnett Squares, 2-factor cross, sex-linked in inheritance; Students choose a male a female superhero and determine phenotypic traits. Then demonstrating recombination by rolling dice to determine offspring traits. Potential assessment will include, but not limited to, a poster, storyline/biography, and illustration (made by hand or computer).

Unit 6: Analyzing Climate Change Data: Interpreting data and making predictions using artic sea ice satellite data from the 1980's to current day. Students predict trends based on prior knowledge; then analyze data from "science on a sphere" website, and compare actual graphical representation to their initial predictions. Students are then tasked with creating an argument to justify the importance of using data collected over long periods of time vs. short periods of time.

4. Instructional Methods and/or Strategies:

- Lab-based learning (skills based labs as well as student designed and implemented labs)
- Cross Cutting Concepts (Patterns, Similarity & Diversity; Cause & Effect; Scale, Proportion & Quantity; Systems & Systems Models; Energy & Matter; Structure & Function; Stability & Change)
- Science & Engineering Practices (Asking Questions & Defining Problems; Developing & Using Models; Planning & Carrying out Investigations; Analyzing & Interpreting Data; Using Mathematics, Information & Computer Technology & Computational Thinking; Constructing Explanations & Designing Solutions; Engaging in Argument from Evidence; Obtaining, Evaluating & Communication Information)
- Four Corners discussions (Agree, Strongly Agree, Disagree, Strongly Disagree)
- Data interpretation and predictions
- Jig Saw research projects (students or student groups research different aspects of a topic and report their learning back to the whole class, e.g. different types of invasive species or genetic disorders)
- Computer based research projects: individual students or groups research
- Evidence based data interpretation (Claim, Evidence and Reasoning writing from labs or research projects)
- Student centered and created activities (e.g. Evolution Island where students determine changes over time to organisms (e.g. rats) on islands with different ecosystems)
- Scientific article reading, annotation and/or class report/presentation
- Using CER (claims, evidence, and reasoning) graphic organizer
- Project Based Learning
- Argument Driven Instruction
- "5 E" Lessons (Engage, Explore, Explain, Elaborate & Evaluate)
- Phenomena

5. Assessment Including Methods and/or Tools:

The fall final exam will cover the first two units and will assess students' understanding through the use of multiple choice questioning, short answer responses, and long answer responses.

The spring final exam will be a cumulative exam, consisting of all four units and all concepts covered. Students will be assessed through multiple choice, short answer responses, and long answer responses. Both mathematical and conceptual concepts will be assessed, with the long answer responses focusing primarily on the application of mathematics and the integration of various chemistry concepts. Additionally, students will also be assessed through a laboratory final, which will assess students' ability as it applies to hands on performance. The laboratory final will be drawn from one of the last five units and will likely cover titrations, calorimetry, and/or galvanic/voltaic cells. Students will be assessed not only on their performance in the lab, but on post-lab questions that delve into the core mathematical and conceptual concepts at hand. Students will submit a written final report that will serve as a portion of their final examination grade.

The evaluation of student progress and evaluation will be based on the following criteria outlined in Board Policy:

- Assessments: 60-75% of the final grade
- Assignments and class discussions: 25-40% of the final grade