Glendale Unified School District

High School

January 19, 2021

Department:	Science
Course Title:	The Living Earth
Course Code:	7173/7174
Grade Level(s):	9-12
School(s) Course Offered:	Clark Magnet High School, Crescenta Valley High School, Daily High School, Glendale High School, Hoover High School
UC/CSU Approved (Y/N, Subject):	Yes, (D) Science
Course Credits:	10
Recommended Prerequisite:	None
Recommended Textbook:	California HMH Science Dimensions – The Living Earth (2020)
Course Overview:	The Living Earth is a lab science course based upon the California Next Generation Science Standards (CA NGSS), authentically integrating Earth and space science content with life science when applicable. The Disciplinary Core Ideas addressed are From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Heredity: Inheritance and Variation of Traits; Biological Evolution: Unity and Diversity; Earth's Systems; Earth's Place in the Universe; and Earth and Human Activity. Additionally, the course includes Engineering Design and Links Among Engineering, Technology, Science, and Society.

Course Content:

First Semester:

Unit 1: **Living Systems** *(5 weeks)*

A. In this unit about living systems, students use models to illustrate the relationship between components of living and nonliving systems. They use mathematical representations to explain how factors affect population density, distribution, and growth patterns; how limiting factors affect an ecosystem's carrying capacity; and how changes in ecosystems affect ecosystem stability. Students explore how environmental engineers design and evaluate solutions to environmental problems. The following are the guiding questions for the unit. How is the Earth system organized? When studying a population, what features or aspects might scientists focus on? How do changes in ecosystems affect ecosystem stability? How have advances in technology influenced the environment and society?
   - The learning experiences in this unit prepare students for mastery of the following 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.
     - 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.
     - 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.
     - 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.
   - The learning experiences in this unit prepare students for mastery of the following Environmental Principles & Concepts:
     - Principle 1 – People Depend on Natural Systems
     - Principle 2 – People Influence Natural Systems

B. Lessons
   - Lesson 1 – In this lesson, students will explore properties of open and closed systems and learn how to use models to simulate systems and interactions **(SEP – Developing and Using Models, CCC – Systems and System Models).** They will learn that a system is made of parts, and that models are used to explain interactions within and between systems at different scales **(DCI – LS1.A, CCC –**

Scale, Proportion, and Quantity). Students will use models to explore the hierarchical organization of the Earth system and the biosphere, and the interactions of organisms in ecosystems **(SEP – Developing and Using Models, DCI – LS1.A, CCC – Systems and System Models)**. They will learn that complex interdependent relationships within an ecosystem, such as predation and competition, contribute to its stability over time, even as the ecosystem remains dynamic **(DCI – LS2.A)**. Students use and develop models and use mathematical representations to understand ecological relationships and analyze evidence to explain how these relationships contribute to ecosystem stability **(SEP – Using Mathematics and Computational Thinking)**. Finally, students model a real-world system to design a solution **(SEP – Constructing Explanations and Designing Solutions)**.

- Lesson 2 – In this lesson, students will use mathematical representations to examine populations at different scales. Students will learn that samples of individuals can be counted with various methods and the smaller sample can be extrapolated to the larger **(SEP – Using Mathematical and Computational Thinking, CCC – Scale, Proportion, and Quantity)**. Students will learn that organisms would have the capacity to produce populations of great size if not limited in some way **(DCI – LS2.A, SEP – Using Mathematical and Computational Thinking, CCC – Scale, Proportion, and Quantity)**. Students will use mathematical representations to explain how limiting factors affect populations and what an ecosystem can support. They learn how scientific understanding of ecosystem dynamics and populations is subject to change based on new evidence gathered from decades of research **(DCI – LS2.C, CCC – Scale, Proportion, and Quantity)**.
- Lesson 3 – In this lesson, students will learn how natural and human-caused ecosystem disturbances affect organisms and biodiversity over time. They will use models and mathematical representations to explain resilience and resistance following an ecosystem disturbance **(CCC – Stability and Change, DCI LS2.C)**. Students will demonstrate that mathematical and computational models can be used to simulate ecological succession and changes – including species biodiversity – within ecosystems over time **(SEP – Using Mathematics and Computational Thinking, CCC – Scale, Proportion, and Quantity, DCI – LS2.A)**.
- Lesson 4 – In this lesson, students will analyze technologies that have been utilized to solve environmental problems and to define benefits and risks **(DCI – ETS2.B)**.

Unit 2: **<u>Carbon in the Earth System</u>** *(3.5 weeks)*

A. In this unit, students use models to explain how living things break down and rearrange carbon-based molecules through biochemical processes such as photosynthesis and cellular respiration. They construct explanations about changes in matter and energy that occur during cellular respiration, and they use a physical model to show how the composition of gases in Earth's atmosphere has changed over time as life on Earth has evolved.

- The learning experiences in this unit prepare students for mastery of the following Performance Expectations:
  - HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
  - 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.
  - 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.
  - 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.
  - HS-ESS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- Environmental Principles & Concepts
  - Principle 2 – People Influence Natural Systems
  - Principle 3 – Natural Systems Change in Ways that People Benefit From and Can Influence
  - Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
- Lessons
  - Lesson 1 – In this lesson, students will develop and use models **(SEP Developing and Using Models)** to illustrate how solar energy is captured and stored through the process of photosynthesis **(DCI LS1.C)**. Students begin to consider the role of photosynthesis in cycling matter and energy through the Earth System **(DCI LS2.B)**. Students also use evidence to make a claim **(SEP Engaging in Argument from Evidence)** that photosynthetic organisms altered the chemical makeup of Earth's systems and therefore set the stage for the evolution of life as we know it **(DCI eSS2.D, DCI ESS2.E)**. In addition, students relate chemical bonding to the stability of atoms, which depends on changes in energy within the system of atoms that bond **(CCC Stability and Change)**. Students also use models to describe and explain **(SEP Constructing Explanations)** the changes of energy and matter in the photosynthesis system in terms of energy and matter flows into, out of, and within that system **(CCC Energy and Matter)**.
  - Lesson 2 – In this lesson, students will construct explanations about changes in matter and energy during cellular respiration **(SEP Constructing Explanations and Designing Solutions, DCI LS1.C)**. Students will illustrate the main inputs and outputs for cellular respiration and describe the flow of energy and matter between photosynthesis and cellular respirations **(CCC Energy and Matter, DCI LS1.C)**. They will model the movement of matter through photosynthesis and cellular respiration and use models to draw

conclusions about matter and energy in cellular respiration **(CCC Energy and Matter, DCI LS1.C)**. By the end of this lesson, students will be able to explain why anaerobic respiration is an important process, and will model the anaerobic and aerobic digestion processes used at wastewater treatment facilities **(SEP Constructing Explanations and Designing Solutions, CCC Systems and System Models, DCI LS2.B).**

Unit 3: **Ecosystem Interactions and Energy Flow** (*3.5 weeks)*

A. In this unit about ecosystem interactions and energy flow, students explain, analyze, and model the flow of matter and energy through trophic levels using food chains, food webs, and pyramid models. They model the flow of matter and energy through Earth's spheres and analyze the impacts of human activities on these cycles. Students create a self-sustaining ecosystem, collect data on the biotic and abiotic factors in the system, and use the data to explain how energy and matter flow through the system.
   - The learning experiences in this unit prepare students for mastery of the following Performance Expectations:
     - 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.
     - HS-LS2-4: Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
     - HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
     - HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
   - Environmental Principles & Concepts
     - Principle 2 – People Influence Natural Systems
     - Principle 3 – Natural Systems Change in Ways that People Benefit From and Can Influence
     - Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems

B. Lessons
   - Lesson 1 – In this lesson, students will apply evidence to construct an explanation of how energy and matter flow through an ecosystem **(SEP Constructing Explanations and Designing Solutions, CCC Energy and Matter, DCI LS2.B)**. Students will learn concepts behind energy and matter flow models such as food chains, food webs, trophic pyramids, energy pyramids, biomass pyramids, and pyramids of numbers **(SEP Developing and Using Models)**. They will learn that in an ecosystem, overall energy is conserved **(CCC Energy and Matter, DCI LS2.B)** s it flows through different organizational levels of living systems **(CCC Energy and Matter, DCI LS2.B)**.
   - Lesson 2 – In this lesson, students will use a model based on evidence to show the flow of matter and energy through cycles of matter **(SEP Developing and Using Models, CCC Energy and Matter, DCI LS2.B.2)**. Students will learn that as matter

and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products **(DCI LS2.B.2)**. Students will construct explanations of how energy drives the cycling of matter within and between systems **(CCC Energy and Matter)**. Students also will learn how new technologies can have deep impacts on society and the environment **(DCI ESS2.D.3)**.

Unit 4: **Evidence for Evolution** (*4 weeks)*

A. In this unit on the evidence for evolution, students describe the changes to Earth's surface over time, relate the fossil record to the theory of evolution, and characterize different eras based on their major events and abundant organisms. Students construct explanations about the evidence that supports common ancestry and evolution in living organisms. They explore how Charles Darwin developed the theory of natural selection and how this theory explains changes in species over time.
   - The learning experiences in this unit prepare students for mastery of the following Performance Expectations:
     - 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.
     - 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.
     - HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
     - HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
     - HS-LS4-1: Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
     - 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.
     - 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.
   - Environmental Principles & Concepts
     - Principle 1 – People Depend on Natural Systems
     - Principle 2 – People Influence Natural Systems
     - Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems

B. Lessons
- Lesson 1 – In this lesson, students use models and mathematical representations **(CCC Cause and Effect, CCC Patterns)** to show how fossils and other pieces of geological evidence are used to understand the vastness of geologic time **(DCI ESS2.E, DCI ESS2.B, DCI ESS1.C)**. Students will demonstrate that mathematical models can be used to express time – including timescales, radiometric dating, and stratigraphy **(DCI PS1.C, DCI LS4.C, DCI ESS2.B)**.
- Lesson 2 – In this lesson, students will apply lines of evidence that support evolution from developmental, anatomical, molecular, and genetic evidence **(DCI LS4.A)**. Students will use these lines of evidence to create a substantiated explanation for evolution based on the idea that natural laws have always and will always operate as they do today. Students will identify patterns in the development and structure of organisms and in the inheritance of DNA **(CCC Patterns)**. Students will explore the relationship between molecular and fossil data and learn how scientist use this relationship to determine mutation rates **(CCC Cause and Effect)**.
- Lesson 3 – In this lesson, students will construct explanations to questions that arise from examining models of natural selection **(SEP Constructing Explanations and Designing Solutions**). Students will apply concepts of statistics and probability to support explanations that organisms with an advantageous trait tend to increase in proportion to organisms lacking this trait **(SEP Analyzing and Interpreting Data)**. In analyzing the data, different patterns may be observed and can provide evidence for causality in explanations of the phenomena **(CCC Patterns)**. Students learn that natural selection results when variation occurs in a populations and that variants positively affecting survival are passed the next generation **(CCC Cause and Effect)**. They learn that adaptation is a consequence of four factors that influence natural selection **(DCI LS4.B, LS4.C)**.

Second Semester-Course Content

Unit 5: **<u>Mechanisms of Inheritance</u>** (*6 weeks)*

A. In this unit about mechanisms of inheritance, students observe patterns and use models to explain how meiosis produces genetically unique cells. They construct explanations about how sexual reproduction, independent assortment, and crossing over increase genetic variation; how traits are passed from parents to offspring; how DNA is the molecule of inheritance; and how the language of DNA is translated into the language of proteins. Students use evidence to explain that gene expression is a regulated process that results in differentiated and specialized cells, and recognize that gene expression occurs differently in prokaryotic and eukaryotic cells.
- The learning experiences in this unit prepare students for mastery of the following 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.
- Environmental Principles & Concepts
  - Principle 1 – People Depend on Natural Systems
  - Principle 3 - Natural Systems Change in Ways that People Benefit From and Can Influence
  - Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems

B. Lessons

- Lesson 1 – In this lesson, students will ask questions when examining models of the processes of meiosis **(SEP Asking Questions and Defining Problems)**. They will examine the cause-and-effect relationship between the events of meiosis, including crossing over and independent assortment of chromosomes, and increase in genetic variation **(CCC Cause and Effect)**. Students learn how the instructions for traits are passed from one generation to another in gametes. They differentiate between the cause of variation due to random arrangement of chromosomes and its effect on offspring. Students will learn that sexual reproduction leads to the formation of new gene combinations and increases genetic variation **(DCI LS3.B)**.
- Lesson 2 – In this lesson, students will ask questions to clarify relationships **(SEP Asking Questions and Defining Problems)** about the role of genes in coding for traits passed to offspring **(DCI LS3.A)**, using terms such as *allele, genotype, phenotype, dominant,* and *recessive* in explanations of this process. Students also will examine how traits are influenced by complex interactions among genes **(CCC Cause and Effect)**.
- Lesson 3 – In this lesson, students ask questions about theories and models of DNA to learn how DNA was determined to be the molecule of inheritance based on historical research evidence **(SEP Asking Questions and Defining Problems)**. They examine the structure of DNA and recognize that its properties reveal its function **(CCC Cause and Effect)**. Students learn that all cells contain genetic information in the form of DNA molecules and that the unique structure of DNA provides the means for replicating the molecule **(DCI LS1.A)**.
- Lesson 4 – In this lesson, students will examine and compare the structures of cellular components and connect the structures to their functions **(CCC Structure and Function)** as they explore the transcription and translation stages of protein synthesis. Students will learn that regions in DNA called genes contain instructions for coding for the formation of proteins **(DCI LS1.A)**. They will construct and explanation based on evidence for how DNA is transcribed into

RNA and how RNA is translated to form proteins **(SEP Constructing Explanations and Designing Solutions)**. Students will also construct an explanation about the effects of gene mutations on the structure of a protein **(CCC Cause and Effect)**. Students will conclude that a change in protein structure can affect the traits of an organism **(DCI LS3.A)**.

- Lesson 5 – In this lesson, students will review the concept that all cells contain genetic information and that 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 the cell **(DCI LS1.A)**. Students construct explanations **(Constructing Explanations and Designing Solutions)** for how the difference in structure of prokaryotic and eukaryotic cells relates to differences in the way gene expression and protein synthesis are regulated in these cell types **(CCC Structure and Function)**. They will learn about the specialized systems within cells that regulate gene expression in prokaryotic and eukaryotic organisms **(DCI LS1.A)**. Students will construct explanations about internal and external factors that influence the expression of particular traits **(SEP Constructing Explanations and Designing Solutions)**. They will consider the impacts of technologies that are used in genetic testing. Students will learn how genetic engineering can affect the probability of occurrences of traits in a population **(DCI LS3.B)**, and use evidence to understand the effects **(CCC Cause and Effect)** of genetic engineering and analyze its potential threats and benefits.

Unit 6: **Genetic Variation and Evolution** *(4 weeks)*

A. In this unit about genetic variation and evolution, students explain how mutations can increase genetic diversity. They explain the different mechanisms that cause populations to evolve, and construct explanations about the evolution of group behavior. Students analyze information about the unique water-collecting adaptations certain organisms have and research how engineers are applying their knowledge of these adaptations to address water shortages in desert environments.
   - The learning experiences in this unit prepare students for mastery of the following Performance Expectations:
     - HS-LS2-8: Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
     - 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.
     - 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.
     - HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
   - Environmental Principles & Concepts
     - Principle 1 – People Depend on Natural Systems

- Principle 3 - Natural Systems Change in Ways that People Benefit From and Can Influence
- Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems

B. Lessons

- Lesson 1 – In this lesson, students will explore how mutagens can result in mutations and analyze changes in DNA to make a cause-and-effect claim about DNA changes on protein structure **(DCI LS3.B, CCC Cause and Effect)**. They will apply concepts of probability to predict the effects of a mutation **(SEP Analyzing and Interpreting Data)**. Students will describe causes and effects of chromosomal mutations **(CCC Cause and Effect)**. They consider how genetic factors can cause mutations **(DCI LS3.B)**, and use evidence to explain how mutations can increase genetic diversity **(SP Engaging in Argument from Evidence)**. Students will make a claim **(SEP Engaging in Argument from Evidence)** for why only mutations in germ cells **(DCI LS#.B)** are passed to offspring and why some mutations affect an organism's phenotype while others do not **(CCC Cause and Effect)**. Students also make a claim for the effect that both genetic and environmental factors **(DCI LS2.B)** have on genetic diversity.
- Lesson 2 – In this lesson, students will consider how existing genetic variation in a population **(DCI LS4.B)** leads to differential survival and reproduction under selective pressure **(DCI LS4.C)**. Students understand that natural selection leads to adaptation **(DCI LS4.C, CCC Patterns)**. Students observe patterns in populations, calculate gene frequencies and probabilities **(SEP Analyzing and Interpreting Data)**, and form explanations **(SEP Constructing Explanations)** about why populations evolve **(CCC Cause and Effect)**. Students consider how environmental changes can contribute to the emergence, expansion, and decline of species **(DCI LS4.C)** and how species can become extinct if they cannot adapt to the altered environment **(DCI LS4.C)**. Students evaluate the merit of explanations for examples of speciation and extinction **(SEP Engaging in Argument from Evidence)**.
- Lesson 3 – In this lesson, students will evaluate evidence for the cause-and-effect relationships that allowed behaviors to evolve through natural selection **(SEP Engaging in Argument from Evidence, DCI LS2.D, CCC Cause and Effect)**. Students evaluate the costs and benefits of individual behavior in terms of energy, risks, and opportunities **(DCI LS2.D)**. Students will apply these scientific principles to group behavior and the chances that an individual and species will survive and reproduce if they perform a behavior **(DCI LS2.D)**. Students will apply these scientific principles to group behavior and the chances that an individual and species will survive and reproduce if they perform a behavior **(Engaging in Argument from Evidence, DCI LS2.D, CCC Cause and Effect)**. Students will also evaluate the ways scientific understanding of animal behavior has changed over time **(DCI LS2.D)**.

Unit 7: **Structure and Function in Living Things** (*5 weeks)*

A. In this unit on structure and function in living things, students use a model to illustrate the roles of the cell cycle and cell division in the development and maintenance of multicellular organisms. They also use models to explain how systems within an organism interact at different levels to carry out functions necessary for life. Students explain how positive and negative feedback loops help an organism maintain homeostasis.
   - The learning experiences in this unit prepare students for mastery of the following 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.
     - HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
     - HS-LS1-4: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
   - Environmental Principles & Concepts
     - Principle 1 – People Depend on Natural Systems
     - Principle 2 – People Influence Natural Systems
     - Principle 3 – Natural Systems Change in Ways that People Benefit From and Can Influence
   - Lessons
     - Lesson 1 – In this lesson, students will develop and use models **(SEP Developing and Using Models)**, to illustrate how the cells of multicellular organisms undergo a controlled cell cycle. Students will learn how individual cells grow and then divide via mitosis, thereby allowing the organisms to grow. Students will develop a model to simulate how mitosis results in two genetically identical cells and why this process is important. Cellular division and differentiation produce and maintain a complex organism **(DCI LS1.B)**. Students will use system models **(CCC Systems and System Models)** to illustrate factors that control the cell cycle. Students use a system model based on mathematic to determine why cells must remain small in size. By comparing ratios of surface area to volume of different-sized cells, students describe the relationship between two quantities. They will learn that the regulation of growth and development sometimes fails, resulting in cancer and other problems. Students are introduced to the three major principles of the cell theory. Using a timeline for the development of the cell theory, students will recognize that a scientific theory is a substantiated explanation of some aspect of the natural world that is based on a body of facts that have been repeatedly confirmed and validated.

- Lesson 2 – In this lesson, students will learn that cells are made of **numerous** parts that interact to perform specific functions. They will use system models **(CCC Systems and System Models)** to explain cellular interactions **(SEP Constructing Explanations and Designing Solutions)**. Students will construct explanations **(SEP Constructing Explanations and Designing Solutions)** about how matter flows through the cell membrane. They develop a model based on evidence to illustrate how matter flows into and out of cells. Students will learn that multicellular organisms have a hierarchical structural organizations **(DCI LS1.A)**. They will develop and use models **(SEP Developing and Using Models)** to illustrate the ways the body systems interact to perform different functions. Students will draw system models **(CCC Systems and System Models)** to illustrate interactions within and among systems at different scales. They will use models to study the processes of cell division and cell differentiation that produce and maintain multicellular organisms **(DCI LS1.B)** to explain how different structures can function together to meet the needs of the whole organisms **(CCC Structure and Function)**.
- Lesson 3 – In this lesson, students will analyze how feedback mechanisms help organisms maintain homeostasis to show how feedback can stabilize or destabilize a system **(CCC Stability and Change)**. Students will carry out investigations to understand how the human body responds to disruptions in homeostasis **(SEP Planning and Carrying Out Investigations)**. They will analyze data to determine how feedback can change a system **(CCC Stability and Change)**. Students consider how feedback mechanisms maintain internal conditions in organisms other than humans. They will use a model to examine how feedback mechanisms stabilize plants affected by drought, and they design and conduct and investigation to measure the effects of exercise on the human body **(SEP Planning and Carrying Out Investigations)**.

Unit 8: **Ecosystem Stability and the Response to Climate Change** *(5 weeks)*

A. In this unit about ecosystem stability and their response to climate change, students explore Earth's energy budget, the global distribution of solar energy, and causes and effects of climate change. They consider the impacts of human activity on biodiversity. Students learn about human population growth, habitat destruction, invasive species, and overexploitation of natural resources. They evaluate various solutions, including engineering solutions, for reducing human impacts on the environment.
   - The learning experiences in this unit prepare students for mastery of the following Performance Expectations:
     - 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.
     - 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-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.
  - HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
- Environmental Principles & Concepts
  - Principle 2 – People Influence Natural Systems
  - Principle 4 – There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
  - Principle 5 – Decisions Affecting Resources and Natural Systems are Complex and Involve Mary Factors

B. Lessons

- Lesson 1 – In this lesson, students will learn about Earth's energy budget and how it is consistent with the concept that the total amount of energy and matter in closed systems is conserved. Students also explore how the foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and re-radiation into space **(DCI ESS2.D, CCC Systems and System Models)**. Students will learn about the factors that influence climate and analyze climate data to explain trends and changes in Earth's climate over time **(SEP Analyzing and Interpreting Data, CCC Stability and Change)**. Students will analyze and develop models to explore the effects of global climate change on Earth's systems **(DCI ESS2.D, CCC System and System Models)**. They obtain, evaluate, and communicate information regarding the role of humans in global climate change and explore engineering strategies involved in designing solutions to deal with those changes **(DCI ESS3.D, CCC Cause and Effect)**.
- Lesson 2 – In this lesson, students will analyze evidence about interdependent relationships as shown by Earth's carrying capacity **(DCI LS2.C)**. They will learn that human population growth leads to global challenges that can be addressed by engineering solutions **(SEP Constructing Explanations and Designing Solutions)**. Students will learn how human activities can lead to loss of biodiversity through habitat destruction and fragmentation **(DCI LS2.C, DCI LS4.D, CCC Cause and Effect)**.They will identify the positive impact that sustainable solutions can have on ecosystems and the environment **(CCC Cause and Effect)**. They will identify the positive impact that sustainable solutions can have on ecosystems and the environment **(CCC Cause and Effect)**. They will learn about disruptions in ecosystem dynamics **(DCI LS4.C, LS4.D)**. They will use a simulation to observe a pattern in the expansion of an invasive species over time and examine potential solutions for the management of invasive species **(SEP Using Mathematics and Computational Thinking, Constructing Explanations**

and Designing Solutions, CCC Patterns). Students will examine the effect of overharvesting and learn that overexploitation of natural resources can upset the stability of natural populations and ecosystems **(CCC Stability and Change)**. They will analyze the factors that contribute to the problem **(SEP Engaging in Argument from Evidence)**. Students will consider how environmental changes have contributed to the expansion and extinction of species **(DCI LS4.C, DCI LS4.D)**.

- Lesson 3 – In this lesson, students will evaluate solutions to world energy consumption based on evidence, criteria, and tradeoff considerations. They will make decisions about the priority of certain criteria while analyzing the causes and effects of wastes generated from the production of electricity **(SEP Asking Questions and Defining Problems, DCI ETS1.B)**. Students will design a green roof prototype to mitigate problems associated with urbanization and consider the social, cultural, and environmental impacts **(SEP Constructing Explanations and Designing Solutions)**. Students will analyze the problem of water pollution and the need for clean water. They will design and evaluate a rainwater harvesting system and produce a graph to model and optimize the system **(DCI ETS1.C)**.