San Mateo Union High School District
Course of Study

Biology, The Living Earth

I. **Course Description**

A. UC/CSU "a-g" Subject Area: D, Science
B. Rationale for Course: The content for Biology 1-2 in grades 9 through 12 will generally be drawn from the Science Content Standards for California Public Schools, the Next Generation Science Standards and the Common Core State Standards for Literacy in History/Social Studies, Science and Technical Subjects.
C. Grade Level: 9-12
D. Credits: 10 Credits per Year (5 per Semester)
E. Prerequisites: None
F. Brief Course Description: During the fall semester, students will study ecology, with an emphasis on interdependency between biotic and abiotic factors on Earth. They will study the dynamics of matter and energy flow through ecosystems, with a focus on the carbon cycle and its flow through the processes of photosynthesis and cellular respiration. Students will also engage in an exploration of DNA, and its role in storing and inheritance of genetic information. Conceptually, students move from the large scale organization of ecosystems, to systems that cycle matter, and smaller systems in organisms that arrange matter through genetic instructions.

In the spring semester, students will zoom in on the basic unit of life--the cell, and learn about how the cell's structure and function allow for the emergent property of unicellular and multicellular life. Students will also apply their knowledge of genetics and study its interaction with the environment, examining the process and evidence for evolution through natural selection. Finally, students will utilize their knowledge of Earth processes and living systems to design solutions to mitigate the effects of human populations on biodiversity and global climate change

II. **Course Purpose: Goals and Student Outcomes**

Students will engage in Science and Engineering Practices (SEPs) and Crosscutting Concepts (CCCs) to build their understanding of how living earth systems interact and influence living organisms and populations, and how these populations in turn influence earth systems. The performance expectations outlined in this course of study and through the Next Generation Science Standards (NGSS) may be addressed in multiple units of study. The goal is that students will be able to meet the demands of the listed performance expectations by the end of the course.

III. **Course Outline**

Instructional Modules	*Ecology- Dynamics and Relationships*	*Ecology- Cycles of Energy and Matter*	*Molecular and Mendelian Genetics*	*Hierarchy: Cells to Systems*	*Mechanisms and Evidence for Evolution*	*Human Impact, Climate Change, & Biodiversity*
Essential Questions (lens to inform instructional design)	*How do living and nonliving factors impact biodiversity and population sizes?* *How do ecosystems and their populations respond to changes in the environment?* *How do living and nonliving factors interact to create an interdependent system of resiliency and change within ecosystems?*	*How do metabolic processes create a pathway of energy required to sustain life?* *How is matter utilized by living organisms, and how are these chemical elements cycled between living and nonliving reservoirs?* *How have living and nonliving factors shaped the biosphere over Earth's history?* *How are photosynthesis and cellular respiration connected?*	*How does the structure of DNA allow for the storage, replication, and inheritance of genetic information?* *What are the processes and factors that generate genetic variation in a population?* *How does the environment interact with traits to bring stability and/or change to a population's gene pool?*	*How does the basic structure of the cell sustain life?* *How do cells grow, reproduce, and respond to their environment?* *How do feedback systems work to maintain homeostasis?* *How do systems work in a multi-celled organism and what happens if there is a change in the system?* *How do organisms survive despite changes in their environment?*	*How do factors such as genetic variation, environmental change, and group behavior allow for the evolution of populations over time?* *How do geological and molecular evidence empirically support the theory of natural selection?* *How have interactions between the biosphere and other Earth systems caused the coevolution of Earth's surface and the life found on it?*	*How has human activity and history been shaped by the availability of Earth's resources and exposure to natural hazards?* *How can data from climate change models be used to design sustainable solutions to address climate change and it's impact on biodiversity?*
Unit Description	Students will be able to explain in detail how living and nonliving	Students will explain how energy flows and matter	Students will describe DNA's role as the universal code of	Students continue to build upon a foundational	Students will begin this module with a study of the mechanisms of	Students will be able to describe and explain how human activity has

	factors interact within ecosystems. Students will use mathematical and graphical models, such as ecological pyramids, predator prey graphs, and population graphs to investigate how populations change, how energy flows, and how ecosystems change over time in response to changes to living and nonliving variables.	(specifically carbon) cycles through abiotic and biotic sources. They will perform experiments and develop models showing how matter and energy are transformed through the processes of photosynthesis and respiration. Using evidence from data sets about earth's changing atmosphere, fossil records, and their models, students will construct an argument about how life has influenced earth's atmosphere.	life and explain how instructions for traits are passed from parents to offspring. Students will explore how genetic variation arises (meiosis, errors during replication, mutations). Students will use concepts of probability and statistics to explain how variation leads to advantageous heritable traits that tend to increase in a population. Finally, students will make hypotheses about how changes in the environment may bring about genetic changes in the population.	understanding of cells, with an emphasis on how cells are organized in hierarchical structures-- from tissues to organs to organ systems. Students will explore how system and feedback mechanisms work to fulfill specific functions within multicellular organisms in order to maintain homeostasis. Students will describe and model the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.	evolution by natural selection. They will be able to make predictions about how interactions between the environment and gene pools can result in evolution. Students will also evaluate data sets and models to determine evidence for evolution. Finally, students will examine phenomena that lead to co-evolution of the Earth's surface its organisms throughout natural history.	affected Earth's resources and ecosystems. Students will use computer models to investigate how Earth's systems respond to human induced changes, such as climate change. Students will make specific forecasts and design solutions to mitigate the negative impacts of these changes on the biosphere.

NGSS Performance Expectations **revisited in other module(s)*	HS-LS2-1 HS-LS2-2 HS-LS2-6*	HS-LS1-5 HS-LS1-6 HS-LS1-7 HS-LS2-3 HS-LS2-4 HS-LS2-5 HS-ESS2-4 HS-ESS2-5 HS-ESS2-6 HS-ESS3-1* HS-ESS3-4 * HS-ESS3-5 * HS-ESS3-6*	HS-LS1-1* HS-LS3-1 HS-LS3-2 HS-LS3-3	HS-LS1-1* HS-LS1-2 HS-LS1-3 HS-LS1-4	HS-LS2-6* HS-LS2-8 HS-LS4-1 HS-LS4-2 HS-LS4-3 HS-LS4-4 HS-LS4-5 HS-ESS1-5 HS-ESS1-6 HS-ESS2-7	HS-LS2-7 HS-LS4-6 HS-ESS3-1* HS-ESS3-4* HS-ESS3-5* HS-ESS3-6*
Disciplinary Core Ideas	• LS2.A: Interdependent Relationships in Ecosystems • LS2.C: Ecosystem Dynamics, Functioning, and Resilience	• LS1.C: Organization for Matter and Energy Flow in Organisms • LS2.B: Cycles of Matter and Energy Flow in Organisms • ESS2.A: Earth Materials and Systems • ESS2.D: Weather and Climate	• LS1.A: Structure and Function • LS3.A: Inheritance of Traits • LS3.B: Variation of Traits	• LS1.A: Structure and Function • LS1.B: Growth and Development of Organisms • LS1.C: Organization for Matter and Energy Flow in Organisms	• LS2.C: Ecosystem Dynamics, Functioning, and Resilience • LS2.D: Social Interactions and Group Behavior • LS4.A: Evidence of Common Ancestry and Diversity • LS4.B: Natural Selection • LS4.C: Adaptation • ESS1.C: The History of Planet Earth • ESS2.B: Plate Tectonics and Large-Scale	• LS2.C: Ecosystem Dynamics, Functioning, and Resilience • LS4.C: Adaptation • LS4.D: Biodiversity and Humans • ESS2.D: Weather and Climate • ESS3.A: Natural Resources • ESS3.B: Natural Hazards • ESS3.C: Human Impacts on Earth Systems • ESS3.D:

					System Interactions • ESS2.D: Weather and Climate • ESS2.E: Biogeology	Global Climate Change
Science and Engineering Practices	• Using Mathematics and Computational Thinking • Engaging in Argument from Evidence • Constructing Explanations and Designing Solutions	• Constructing Explanations and Designing Solutions • Developing and Using Models • Using Mathematics and Computational Thinking • Engaging in Argument from Evidence	• Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Asking Questions and Defining Problems • Analyzing and Interpreting Data	• Constructing Explanations and Designing Solutions • Developing and Using Models • Planning and Carrying Out Investigations	• Obtaining, Evaluating, and Communicating Information • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Analyzing and Interpreting Data	• Using Mathematics and Computational Thinking • Developing and Using Models • Engaging in Argument from Evidence • Constructing Explanations and Designing Solutions
Crosscutting Concepts	• Scale, Proportion & Quantity • Stability and Change • Cause and Effect	• Energy and Matter • System and System Models • Cause and Effect • Structure and Function • Stability and Change	• Cause and Effect • Scale, Proportion & Quantity	• Structure and Function • Systems and System Models • Stability and Change • Energy and Matter	• Patterns • Cause and Effect • Stability and Change	• Stability and Change • Cause and Effect • Systems and System Models • Scale, Proportion & Quantity

IV. **Key Assignments**

This course will afford students opportunities to participate in all phases of the scientific process, including formulation of well-posed scientific questions and hypotheses, design of experiments and/or data collection strategies, analysis of data, and drawing of conclusions. Students will have opportunities to generate claims regarding scientific phenomena, and engage in argument from evidence in support of these claims. When investigating scientific phenomenon, teachers are encouraged to use modeling as a means to describe, predict and test scientific ideas. There are a variety of assignments that teachers can design to facilitate student growth and understanding around the science and engineering practices and crosscutting concepts. Some examples include investigating the inputs and outputs of cell energy processes, simulating changes in gene frequency, modeling ecosystem cycles of energy and matter, and calculating inheritance probabilities. Laboratory or inquiry style investigations should comprise a minimum 20% of in class instruction and practice.

V. **Instructional Methods and/or Strategies including Instructional Technology**
Guided Inquiry through Experimental Design, Direct Instruction, Collaborative Group Work, and/or Independent Research

VI. **Assessment Methods and/or Tools**
Teachers will employ a variety of formative and summative assessment strategies to inform instruction and gauge student learning. Some examples include quizzes, in a digital or paper and pencil format, multiple choice tests, constructed responses to open-ended or closed problems, individual or group research projects including laboratory reports or notebooks.

VII. **Textbook(s) and Supplemental Instructional Materials:** Holt Biology: Student Edition 2004, 1st Edition, by Rinehart and Winston Holt

VIII. **Appendix**

Performance Expectations For Biology, The Living Earth: Links provide details on Disciplinary Core Ideas (DCIs), Science and Engineering Practices (SEPs) and Crosscutting Concepts (CCCs) encapsulated by the designated performance expectation. Some performance expectations, particularly the Earth and Space Science (ESS) standards, are covered partially in this course of study, and the remaining components are covered either in the Chemistry in Earth Systems or Physics in the Universe.

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

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-LS2-1 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-LS2-3 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-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-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-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

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.

HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

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.

HS-LS4-4 Construct an explanation based on evidence for how natural selection leads 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.

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*
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-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
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
HS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
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.
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
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-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.