Pasadena Unified School District

BIOLOGY: 9 – 12TH

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Stage 1: Desired Outcomes

Priority Standards

What Priority Next Generation Science Standards frame the learning objectives of this unit?

- **HS-LS2-1:** Use mathematics 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 and 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 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.

Supporting Standards

What supporting Next Generation Science Standards and Common Core Standards are important to the objectives of this unit?

Next Generation Science Standards-

- **LS2A: Interdependent Relationships in Ecosystems**
  - Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.
- **LS2B: Cycles of Matter and Energy Transfer in Ecosystems**
  - Photosynthesis and cellular respiration provide most of the energy for life processes.
  - Plants or algae form the lowest level of the food web.
  - Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans and geosphere through chemical, physical, geological, and biological processes.
- **LS2C: Ecosystem Dynamics, Functioning, and Resilience**
  - A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.
  - Anthropogenic changes in the environment—including habitat, destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- **LS2D: Social Interactions and Group Behavior**

- Biodiversity is increased by the formation of new species.
- Humans depend on the living world for the resources and other benefits provided by biodiversity.

Common Core Standards

ELA/Literacy –

- **RST.9-10.8**: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- **RST.11-12.1**: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- **RST.11-12.7**: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.8**: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- **WHST.9-12.2**: Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- **WHST.9-12.5**: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- **WHST.9-12.7**: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Mathematics –

- **MP.2**: Reason abstractly and quantitatively.
- **MP.4**: Model with mathematics.
- **HSN.Q.A.1**: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- **HSN.Q.A.2**: Define appropriate quantities for the purpose of descriptive modeling.
- **HSN.Q.A.3**: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- **HSS-ID.A.1**: Represent data with plots on the real number line.
- **HSS-IC.A.1**: Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- **HSS-IC.B.6**: Evaluate reports based on data.

21st Century Skills

What 21st Century Skills will students be expected to demonstrate upon completion of this unit?

☒ *Learning & Innovation (4 C's)* ☒ *Information, Media & Technology*

☒ *Life & Career* ☒ *21st Century Themes*

Enduring Understandings *Big ideas at heart of the discipline; specific understandings desired about them.*	Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*
• Factors that affect carrying capacity of ecosystems at different scales. • Factors affecting biodiversity and populations in ecosystems of different scales. • The cycling of matter and flow of energy in aerobic and anaerobic conditions. • The cycling of matter and flow of energy among organisms in an ecosystem. • Photosynthetic processes and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. • 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. • Reducing the impacts of human activities on the environment and biodiversity. • The role of group behavior on individual and species' chances to survive and reproduce.	• Why are there only a few top predators in ecosystems? • How do humans impact the biodiversity of ecosystems? • What problems arise when a new species is introduced to a non-native ecosystem? • What are the consequences of human actions on both local and global ecosystems? • How are biological systems from populations, communities, and ecosystems affected by complex biotic and abiotic interactions? • How does biodiversity within an ecosystem influence the stability of the ecosystem? • How does the conservation of matter apply to ecosystems? • How does carrying capacity help maintain the balance of species within an ecosystem? • What factors determine whether a species will evolve or become extinct?
Key Knowledge *As a result of this unit, students will know…*	**Key Skills** *As a result of this unit, students will be able to…*
• How ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. • How a complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. • How photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. • How plants or algae form the lowest level of the food web. • The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. • How photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. • How a complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. • How anthropogenic changes (induced by human activity) in the	• Students will use mathematics 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 construct and revise an explanation based on evidence for the cycling of matter and flow of energy and aerobic and anaerobic conditions. • Students will use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. • 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 evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable 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.

environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. • How humans depend on the living world for the resources and other benefits provided by biodiversity.	• Students will evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Stage 2: Assessment

Performance Task: Acid Rain	Other Evidence: *(project benchmarks quizzes, unit tests, multiple choice tests, etc)*

THE INVESTIGATION
 	
OBJECTIVES
 	
In this experiment, you will
• Use a pH Sensor to measure changes in pH.
• Study the effect of dissolved CO_2 on the pH of distilled water.
• Study the effect of dissolving H_2SO_4 in various waters on pH.
• Learn why some bodies of water are more vulnerable to acid rain than others.
	• Assigned readings and reading assignments
	• Class notes
	• Videos/visual aids
	• Lab notebook (for lab work)
	• Other related activities
	  ○ Animal Population Lab
	  ○ Biodiversity in Ponds
	  ○ Seed Germination Lab
	• Vernier Lab
	  ○ Acid Rain Lab

Name of Project:	Acid Rain		**Duration:**	2 weeks
Subject/Course:	Biology	**Teacher(s): Secondary Biology Teachers**	**Grade Level:**	9th through 12th
Other Subject Areas to Be Included:	Mathematics, English, and History			

Project Idea
Summary of the issue, challenge, investigation, scenario, or problem:

Acid rain is a topic of much concern in today's world. As carbon dioxide gas, CO_2, dissolves in water droplets of unpolluted air, the following reaction occurs:

$$CO_2 + H_2O \longleftrightarrow H_2CO_3$$

H_2CO_3 is a weak acid that causes the rain from unpolluted air to be slightly acidic. This source of "acid rain" is not usually considered to be a pollutant, since it is natural and usually does not alter the pH of rain water very much. Oxides of sulfur dissolve in water droplets to cause more serious problems. Sulfur dioxide dissolves to produce sulfurous acid, H_2SO_3, by the equation:

$$SO_2 + H_2O \longleftrightarrow H_2SO_3$$

This source of sulfur dioxide can occur naturally, as from volcanic gases. More often, however, sulfur dioxide is considered a pollutant, since it is a by-product of fossil-fuel combustion.

The acidity of a solution can be expressed using the pH scale, which ranges from 0 to 14. Solutions with a pH above 7 are basic, solutions with pH below 7 are acidic, and a neutral solution has a pH of 7. In Part I of this experiment, you will study how the pH of water changes when CO_2 is dissolved in water. In Part II, you will study the effect sulfuric acid has on the pH of different water types.

FOR THIS LAB, ALL STUDENTS ARE REQUIRED TO COMPLETE THE EXTENSION SECTION OF THIS PERFORMANCE TASK.

Driving Questions

- How does the pH of water change when CO_2 is dissolved in water?
- What is the effect of sulfuric acid on the pH of different water types?

Content Standards to be taught and assessed**:**	What **Key Knowledge** will students master? What will they know? Enduring Understandings? *Key Knowledge* • Learn how to distinguish between abiotic and biotic factors in an ecosystem. • Trace the flow energy through living systems. • Describe how nutrients move through living and nonliving parts of an ecosystem. • Analyze how rates of birth, immigration, emigration, and death affect population growth. • Explain how climate, human activity, non-native species or changes in population size affect an ecosystem. *Enduring Understandings* • Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems). • Predict the effects of a change in the community's populations on the community. • Use visual representations to analyze situations or solve problems qualitatively to illustrate interactions among living systems within their environment. • Predict the effects of a change in the community's populations on the community. • Predict consequences of human actions on both local and global ecosystems. • Make scientific claims and predictions about how biodiversity within an ecosystem influences ecosystem stability. What Key Skills will students be asked to develop and/or apply? • Students will know how interactions between and within populations influence patterns of species distribution and abundance of local and global ecosystems changes over time. • Students will understand how the diversity of a species within an ecosystem influences the stability of the ecosystem. • Students will know different ways in which communities of organisms interact within their environment. • Students will understand the factors that govern energy capture, allocation, storage, and transfer between producers and consumers in a terrestrial ecosystem. • Students will understand the consequences of human actions on both local and global ecosystems.

21st Century Skills to be taught and assessed**:** *How will they be taught and assessed?*	Collaboration • Students will work together in small groups and will complete the Acid Rain lab.	☒	Creativity/Innovation • Students will be given the opportunity for inquiry designed based labs.	☒
	Communication (Oral Presentation) • Students will present to their peers their performance task results in the form of a power point presentation or a scientific poster.	☒	Critical Thinking/Problem Solving • Students will learn to develop critical thinking and problem solving skills as a team and as individuals as they move through the conduction of the performance task.	☒

	Life & Career: • Students will be taught critical thinking, problem solving and teamwork building skills.	☒	Other: • Students will be able to run a lab while conducting the control and the experimental study at the same time with their group members of no more than four.	☒

Major Products & Performances	Group:	• Power Point Presentation to their peers • Scientific Poster Presentations within their school to their community (school staff, parents and peers)	**Presentation Audience** *(entire project)* **Presentation Audience:** Class School	
	Individual:	• Lab Report • Science Notebook • Notes • Exams	☒ Class ☒ School ☒ Community ☒ Experts CAPSI/CalTech and UCLA CA Science Project ☒ Web UCLA TIIP Web Grant Portfolio ☐ Other:	

LEARNING PLAN **Does it incorporate Authenticity, Choice, Inquiry & students playing the Active Role?**

PBL Guiding Principles:

☒ **Authentic,** compelling scenario that matters to student, field, or community
☒ Considers multiple roles/perspectives
☒ Leads to a product for an **authentic** audience
☒ Allows for student **choice**
☒ Point of view/argument that faces opposition
☒ Engaging, high stakes, with a sense of urgency
☒ Transforms or creates content, and opens new questions or cycles of inquiry

What **Performance Assessment Task(s)** will be generated by this project *that is aligned to standards and key skills*:

☒ Math Analysis (Problem Solving) ☒ English Textual Analysis ☒ English Research/Argumentation ☒ Scientific Research ☒ Scientific Inquiry ☒ History/Social Science Research/Inquiry ☐ Other:	Notes: Attach Stage 2 Task Planning Document

L E A R N I N G P L A N

Entry Event to launch inquiry, engage students: *See part B*		**Benchmark Order**	**Benchmark Category**	**Benchmark Description - what is the assessment?**	**Benchmark Skills – what will this help them to be able to do?** *If a benchmark asks them to report on what they have researched, then they will be able to complete independent research, summarize information, synthesize information, etc.*
Assessments *Under each type of assessment there are ideas as to some you might use. These lists are not exhaustive. You may choose to include others not listed.* *The number of benchmarks may be more or less than the number listed. Feel free to document the amount that you will use. If you need more, you may use another sheet.*	**Formative Assessments** (During Project) i.e., *Quizzes/Tests, Journal/Learning Log, Preliminary Plans/Outlines/Prototypes, Rough Drafts, Practice Presentations, Notes, Checklists, Concept Maps*	Benchmark 1:	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	Learn how to distinguish between abiotic and biotic factors in an ecosystem.	Analyze data to identify possible patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems).
		Benchmark 2 :	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	Trace the flow energy through living systems.	Predict the effects of a change in the community's populations on the community.
		Benchmark 3 :	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	Describe how nutrients move through living and nonliving parts of an ecosystem.	Use visual representations to analyze situations or solve problems qualitatively to illustrate interactions among living systems within their environment.
		Benchmark 4 :	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	Analyze how rates of birth, immigration, emigration, and death affect population growth.	Predict the effects of a change in the community's populations on the community.
		Benchmark 5 :	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	Explain how climate, human activity, non-native species or changes in population size affect an ecosystem.	Predict consequences of human actions on both local and global ecosystems.
	Summative Assessments (End of Project) i.e.,*Written Product(s) with*	Benchmark 6 :	☒Know (mastery) ☒Do (application) ☒Reflect (metacognition)	How the pH of water changes when CO_2 is dissolved in water.	Use a pH Sensor to measure changes in pH. Study the effect of dissolved CO_2 on

	rubric, Oral Presentation with rubric, Multiple Choice/Short Answer Test, Essay Test, Other Product(s) or Performance(s) with Rubric, Self-Evaluation, Peer Evaluation	Benchmark 6 :	☒ Know (mastery) ☒ Do (application) ☒ Reflect (metacognition)	Know what the effect of sulfuric acid has on the pH of different water types.	the pH of distilled water. Study the effect of dissolving H_2SO_4 in various waters on pH. Learn why some bodies of water are more vulnerable to acid rain than others. Design experimental study Complete Laboratory Report
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		
		Benchmark :	☐ Know (mastery) ☐ Do (application) ☐ Reflect (metacognition)		

PART B:

Project Launch – Start with a Bang!

Launch Guiding Principles:

- ☒ High interest, provocative, communicates a sense of urgency
- ☒ Provides overview of project without going into too much detail
- ☒ Provides models/examples of culminating products
- ☒ Provides timeline with major benchmarks
- ☒ Motivating - urges students to explore what is possible within the project
- ☒ Presents an exciting challenge that also feels attainable, students can imagine themselves accomplishing the project
- ☒ Addresses the question of "So what…?"

What venue will you use to launch this project (community meeting, multiple classes, within your class, field trip, etc.)?	**Who will be involved in the launch (multiple teachers, just you)?**	**When will you launch this project?**
Launch Agenda: • ALL Biology Courses	Staff Roles: Multiple Teachers on Site, district adminstrators, CAPSI/CalTech and UCLA Experts.	FALL 2013 District Wide

Action Steps/Follow Up after the launch:

- Continued Support and Training for Science Teachers throughout the year (PD days)
- Provide Evidence of Student Work Samples
- Classroom Visitations to see the Implementation of the Performance Tasks at hand

Resources Needed	**On-site people, facilities:**	Science Department on Site
	Equipment:	Laptops, sensor probes and printers
	Materials:	LabQuest LabQuest App Vernier pH Sensor Logger *Pro* or graph paper 250 mL and 100 mL beaker buffer solution dilute H_2SO_4 ring stand and utility clamp straw wash bottle with distilled water water from a lake water from the ocean (optional)
	Community resources:	Oak Crest Institute of Science, CAPSI/CalTech, UCLA CA Science Project

Reflection Methods	**(Individual, Group, and/or Whole Class)**	Journal/Learning Log **Journal/Learning Log** • *Individual* ○ Students will write in their lab notebook. Students are responsible for maintaining their notebook. • *Group* ○ Students will record data and observation as it pertains to their experiments. They will also write/record their final conclusions and evaluations at the end of each experiment.	☒	Focus Group	☐
		Whole-Class Discussion • *Individual/Group* ○ As part of the lesson, students will be presented with information as it pertains to the lesson and the experiment they might conduct. • *Group* Students can present their findings to the class.	☒	Fishbowl Discussion	☐
		Survey	☐	Other:	☐