

December 2012 (Updated 6-30-14)

Marine Biology Course of Study

TUHSD Mission Statement

THE TAMALPAIS UNION HIGH SCHOOL DISTRICT is dedicated to the development of creative, passionate, and self-motivated learners. Upon graduation, students will be prepared for engaged citizenship and able to contribute individually and collaboratively in order to address the challenges of a dynamic and diverse world. To these ends, all students will demonstrate mastery of core competencies and will be offered meaningful learning experiences to enable them to access and critically analyze information, pose substantive questions, and communicate effectively.

Introduction

Course: Marine Biology

Department: Science

Grade Levels: 11 and 12

Teacher Proposing: April Tucker

Justifications for Course

A. How will the course bring the mission statement to life in the classroom?

Marine Biology will provide students with experiences in science that are creative, problem/project-based, hands-on, contextual, and inquiry-based. The marine science curriculum will allow students to develop problem-solving skills in order to view the natural world and its phenomena through a variety of conceptual lenses. Marine Biology will be experiential, whether students are conducting research that generates real data for real audiences or determining how best to desalinate a water sample. Marine Biology assessments will be both informal and formal. Informally, student understanding is gauged through such mechanisms as class activities and one-on-one interactions. Portfolios comprised of standards-referenced assessments provide a formal means of assessment. Presentations serve to measure understanding in the environmental marine studies. Students become critical thinkers, experimenters, researchers, and problem solvers. The experiential nature of Marine Biology will be one of its strengths. Problem/project-based learning empowers students to engage in a discipline rather than merely learn about the discoveries of others. The ability to design and perform scientific inquiries is as important as the content learned in traditional classroom settings. Marine Biology will offer students the opportunity to design and engage in real inquiry while also learning scientific content salient to the inquiry at hand. Marine Biology will be contextual and conceptual. By placing science in context, students are able to understand larger concepts, both scientific and related to other disciplines, and the relationships that exist among them. Students will begin to view themselves as part of the natural world rather than apart from it. Another way in which Marine Biology will provide meaningful learning experiences is through interdisciplinary content. These learning experiences also link to the contextualization of science discussed above. Science does not exist in a vacuum; it is entangled with other disciplines. To separate them is to deny our lived experience in the world. The Marine Biology course will offer students the opportunity to critically examine their impact on the world in which we live. The course will also offer a venue for students to examine relevant issues in the marine environment. The course will aim to be a venue for community based, citizen science projects. Through engagement in projects, students become active members of their community while engaging in authentic, messy, and meaningful scientific research. Marine Biology will provide a means for students to practice research skills and produce real data that relate to real marine issues. Another strength of the course is that it will be experiential, centered on a problem or project, contextual, and conceptual. Instruction will be student-centered and constructivist in nature. The instructor proposing this course will work to facilitate meaningful

experiences in which students are active constructors of knowledge, rather than empty vessels to be filled. To accommodate varied learning styles, instruction includes the explore-flip-apply model, hands-on activities, inquiry based labs and activities, research, peer collaboration, and Project centered units directed by a driving question. Marine Biology assessments will allow flexibility in how students demonstrate their learning while still referencing programmatic goals and learning outcomes. Unlike portfolios, which are merely collections of work, science portfolios will be formal mechanism of assessment. They will contain goals-referenced “prompts” in which students will demonstrate understanding through answering open-ended questions, solving problems, designing and performing experiments, and/or giving presentations. In addition, portfolios will contain a synthesizing project and a metacognitive reflection, which encourage students to delve deeper into both their understanding of concepts and of themselves as learners. Since developing understanding is an iterative process, students are encouraged to revise their work until it meets the program goal/learning outcome outlined in the rubric accompanying each assessment. Backwards design will guide science assessments, taking into account what is important for students to know and be able to do prior to designing everyday lessons. This design process ensures intentionality in the Marine Biology curriculum assessments while also avoiding regurgitation of disconnected facts.

B. In what ways does this course address student interest?

- a. Anecdotally, the interest level is perceived to be extremely high.
- b. Since submitting documents to the DO three and a half years ago hundreds of students have expressed strong interest.
- c. An online survey was created on a wikispace using survey monkey. The results are as follows:

85% of responders indicated they would take a marine science course. Of those that said “no”, most are seniors and said they wouldn’t because they would not be here. The following comments were offered on the survey:

- *GET THIS CLASS'S I WANA BE A MARINE BIOLOGIST*
- *sharks are awesome*
- *I think it would amazing, relevant and interesting. please do it!!!*
- *that would be pretty dope i know a bunch of fools like marine biology*
- *An extremely useful resource could be the marine mammal center which is very close to Tam.*
- *sounds fun*
- *Marine biology has always interested me, which is one of the reasons I am now taking environmental science (because we learn a little bit about Marine Biology). However, a course that just focuses on Marine Biology would be awesome!*
- *An interesting option, i would definably look into such a course if i had the option to.*
- *It would be very fun especially with Tucker*
- *Marine biology is cool!*
- *Seems like a good idea but personally I am not interested.*
- *It would be a great new way of learning science and Ms. Tucker would be a great teacher for it!*
- *I think having a marine science class would be so rad. I have found that environmental science has really interested me and i find myself way more engaged with something that we interact with on a more frequent bases and expanding that to marine life would be something i would be amped to take part in.*
- *I would love to take this class from you! Really enjoy having you as a teacher.*
- *Yes if it is UC approved course I would love to take it!*

- *Please offer this course!*
- *Based off of my own dreams at some points in my life, I personally feel that like me, many students have desired to study sea life and travel in mini-sub's at the bottom of the ocean exploring sea life. I think if this class was offered, it would give this opportunity to more students who want to pursue this.*
- *It sounds like a fun class but I will no longer have the opportunity to take it because I'm a senior.*
- *I would love to know more about the organism that surround me every day here in Marine.*
- *I really would like to take this class! As you know I can struggle with Science but your flipped teaching has really worked a ton for me. I would like to continue with this model if at all possible. So if you need some sort of student help with it please let me know I am very interested in this.*
- *I think it's an interesting course*
- *I would absolutely love to take a marine science class!*
- *It seems like it would be cool but it's just not my thing.*

C. How will this course prepare students for post high school options?

- a. The course is designed around the 21st century learning skills listed below. These skills are critical for students to obtain in our rapidly changing society. These skills prepare students for post-secondary education, technical school, entering the workforce and just being positive contributing members of society.
- b. Students will be taught to be effective communicators, informed thinkers (critical, creative and problem solving), self-directed learners, collaborative workers and responsible members of society. This will be accomplished through a great variety of instruction strategies throughout the curriculum.
- c. Students will use state of the art technology in the classroom on almost a daily basis. This will include but is not limited to the following: iPads, iPods, phones, numerous internet resources, *gamefication* software and hardware, Blogs, wikispaces, social media (secure forms just for teachers and students), texting (secure for students and teacher), video, video-editing, voicethread, screenchomp, subject specific apps and Marine Biology technology tools. This will provide students with necessary technology skills for any post high school endeavor.
- d. The curriculum is designed to develop critical thinking and problem solving skills. It is designed using the explore-flip-apply model. This is an inquiry based flip model, which beautifully teaches these essential thinking skills. Additionally, students will engage in actual marine research which will further develop problem solving skills, provide opportunities to apply scientific process and work in a team (*again, all skills essential for life beyond high school*).
- e. Students will be exposed to many scientific studies, journals, research etc. These will be in both electronic (internet) and hard copy forms. Students will learn how to discern valid scientific information. They will be asked to question all research and sources they are exposed to. This is a critical skill for their adult life as they are bombarded with information on a daily basis.

D. What learning need does this course meet?

- a. This course will integrate chemistry, biology and physics topics under one common theme of Marine Biology. This is unique because most of our current upper division science elective courses are very subject specific. Marine Biology will thread all science subject areas through

one unifying theme. This is truly how science and the natural world work. This also provides greater context and structure for students studying a variety of integrated sciences.

- b. This is a mastery based flipped course designed using the explore-flip-apply model. This addresses multiple learning styles while also reinforcing inquiry and 21st century skills. This is helpful for students who struggle with homework and students that need to see and hear the material multiple times on their own terms.

E. How does this course provide a new opportunity or pathway for students to fulfill district requirements?

The Marine Biology course will provide a lab science course that can be taken as an elective. This course will integrate chemistry, biology and physics topics under one common theme of Marine Biology. This is unique because most of our current upper division science elective courses are very subject specific. Marine Biology will thread all science subject areas through one unifying theme. This is truly how science and the natural world work. This also provides greater context and structure for students studying a variety of integrated sciences. We are in one of the most desirable areas to study Marine Biology. Resources are plentiful. As a former marine scientist myself I have numerous connections that would allow a great deal of real research opportunities for students not just laboratory simulations. The students would have extraordinary opportunities for field study. Additionally, this course will be flipped. The curriculum will be all inquiry based and taught to mastery.

F. What is the need for a new course as opposed to new units of study within an existing course?

As described above this would be a course that infuses all science subject areas under one unifying theme of Marine Biology. Currently, most upper division science electives are subject specific. Some of the Marine Biology topics are briefly touched on in other subject areas such as integrated science but not in depth. There is not room in a subject specific course to fit all the marine topics. Also, the topics would be choppy and separate rather than integrated in one course providing students a much richer understanding of each concept.

G. What are some potential impediments to this course succeeding?

Ability/Approval to take key field trips. This would not prevent any of the content to change but could impact how it is taught and assessed.

H. In what ways might this course address the needs of our various student subpopulations?

- a. The Marine Biology course envisioned will be an inquiry/project based laboratory course. The curriculum will be flipped and taught to mastery. This allows students to be graded on what they truly know rather than how many assignments they complete. The course will be completely infused with in-class technology that will allow for a great scope of differentiated instruction. The flipped model has proven to be exceptionally effective with all students. One area that some students struggle with is homework completion and follow-through. The flipped model completely changes this model and students struggle much less with the homework concern. Ultimately, progress will be monitored and results oriented.

- b. The content is immediately relative to our SF Bay area aquatic environments. The curriculum will be current and real world connected. Students will have many hands-on experiences. Our region also provides many options for fieldwork and real research experiences. Additionally, students struggle with the vocabulary laden science courses. While Marine Biology is also heavy in vocabulary the design of this course will not focus on memorizing terms but rather applying concepts.
- c. Marine Biology will provide a variety of learning environments that are conducive to our multicultural society. The curriculum will address this multicultural society as it is responsible for major discoveries in the advancement of Marine Biology and marine technology.
- d. Differentiated instruction. Using the following methods: Adjusting questions, anchoring activities, choice activities, centers, flexibility, grouping, independent study, tiered lessons.

Entry Requirements

- A. **List of entry requirements:** Completion of Integrated Science 1/2 and Integrated Science 3/4
- B. **Reasons for requirements:** Integrated Science is already required of all students. The Integrated Science sequence will provide the foundational skills and concepts in the physical, geological and biological sciences necessary to apply in Marine Biology. Marine Biology will spiral off of many of these concepts.
- C. **Pre-requisite courses:** Integrated Science 1/2 and 3/4

Skills or outcomes that will be met

Students will:

1. Understand that water exhibits properties that play a vital role on Earth.
2. Understand how aquatic environments interact with the land and atmosphere.
3. Understand and apply ecological principles to the field of marine biology.
4. Understand how aquatic organisms interact in complex ecosystems.
5. Understand the role of humans in the aquatic environment and how we can act to preserve its health.
6. Understand and apply current technologies to the field of marine biology.

Program Goals/learning outcomes that will be met

How does this course align with existing program goals in one or more departments/disciplines?

At the time this document was written the TUHSD science department has not finalized the program goals and learning outcomes for integrated science. Development of program goals has also not been explored for upper division science courses. The course has been designed around the draft form of the program goals and learning outcomes. The UbD design documents from all science courses that currently exist in the district were also utilized. All goals and outcomes are included in the proposal in the unit outline below.

Articulation within and across department(s)

Department discussion statement

The proposal was presented to the Tamalpais HS Science Department on December 10, 2012 during the department meeting. The response was overwhelmingly positive. All teachers in the department agree we should offer this course. They indicated the process should be expedited given that this was originally proposed in 2008. They indicated it should be offered as a lab course but the

department is open to a non-lab course. A vote was taken and 100% of all science teachers would like the course offered. Some quotes from the meeting:

“Can I audit your course because it sounds awesome.”

“I would so take this class if I was in high school.”

“We offered this course at my previous high school with great success. It served the struggling students well.”

“How can we help you get this course on the books?”

Teacher Leader signature: John Ginsburg 12-10-12

Can this course be taught by other qualified members of the department and across sites?

Yes

Course of Study

Introduction

A. **Course Name:** Marine Biology

B. **Department:** Science

C. **Grade Levels:** 11 and 12

D. **Length of Course:** Full year

Justification

Justification and description of course:

The Marine Biology course will provide a lab science course that can be taken as an elective. This course will integrate chemistry, biology and physics topics under one common theme of Marine Biology. This is unique because most of our current upper division science elective courses are very subject specific. Marine Biology will thread all science subject areas through one unifying theme. This is truly how science and the natural world work. This also provides greater context and structure for students studying a variety of integrated sciences. We are in one of the most desirable areas to study Marine Biology. Resources are plentiful. As a former marine scientist, the author of this document has numerous connections that would allow a great deal of real research opportunities for students not just laboratory simulations. The students would have extraordinary opportunities for field study.

Additionally, this course will be flipped. The curriculum will be all inquiry based and taught to mastery.

Philosophy

The philosophy of Marine Biology is to create student understanding of the importance of the diverse marine environments and their interdependence with humanity. Our local marine ecosystems provide us with a unique cross section to study and serve as a basis for further study of other global marine environments. Upon completion of this course, students will have gained an appreciation and understanding of the interconnectivity of the ocean and how it relates to the large global picture.

The above philosophy will be met by providing students with a thorough survey of living organisms and their adaptations. An understanding of the physical processes that shape the various aspects of the oceans How humans are affecting large scale changes that cumulatively make an impact over time.

Course Description

Marine Biology is a full year elective course for students with an interest in the many aspects of marine environments. The course's major concepts focus on marine organisms and their habitats, the physical and chemical properties of the ocean, and how humans are impacting oceans on a global scale. The course's highlights include hands on inquiry-based projects, field trips, participation in real marine research and an exciting introduction to the amazing and diverse world beneath the sea.

1. Entry Requirements

List of entry requirements: Completion of Integrated Science 1/2 and Integrated Science 3/4

Reasons for requirements: Integrated Science is already required of all students. The Integrated Science sequence will provide the foundational skills and concepts in the physical, geological and biological sciences necessary to apply in Marine Biology.

2. Program Goals/Learning Outcomes

UbD equivalents included in the curriculum outlined below.

3. Learning Progressions and Proficiency Scales (aligned with program goals).

These are still under development in the district science department. I can easily redesign the curriculum below utilizing the GVC format.

SUGGESTED SCOPE AND SEQUENCE OF CURRICULUM

Unit 1: Aquariums

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Marine Biology is a multi-discipline branch of Earth Science that studies the oceans of the world and the processes within it including biology, chemistry, geology, meteorology, physics and geography.	<p>Key Terms Biology Chemistry Geology Meteorology Physics Geography</p> <p>Skills Exposure to different career options in the sciences.</p>	<p>Key Terms Marine Biology Oceanography Physical Oceanography Chemical Oceanography Biological Oceanography Geological Oceanography</p> <p>Skills Recognize that there are a variety of career options in the marine sciences.</p>	<p>Identify some other science disciplines.</p> <p>List the four main branches of oceanography.</p> <p>List career options in the various branches of marine science.</p>	<p>Compare and contrast marine science to other science disciplines.</p> <p>Describe the four main branches of oceanography.</p> <p>Describe careers available in the various branches of marine science and the duties and responsibilities of each.</p>	<p>I can compare and contrast aspects of marine science to aspects of other science disciplines.</p> <p>I can list and describe the four main branches of oceanography.</p> <p>I can list and describe at least four careers in the various branches of marine science. I can list and describe the duties and responsibilities of each.</p>	<p>Complete a chart comparing marine science to other science disciplines.</p> <p>Create a mock Wikipedia entry that defines oceanography and the four main branches of oceanography.</p> <p>Create a questionnaire and use it to complete a web interview with an oceanographer. Use the information to write a narrative biography.</p> <p>Create a help wanted advertisement for a specific marine career.</p>

Unit 1: Aquariums

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Establishing and maintaining a marine aquarium acts as a model of a natural aquatic system. There are basic elements needed to create a functioning aquarium and effective methods to maintaining the aquarium. A healthy aquarium requires biological, chemical and physical cycles.	<p>Key Terms Aquarium toxins pH</p> <p>Skills Familiarity with saltwater aquariums. Know the pH scale and what it represents.</p>	<p>Key Terms Specific gravity Filtration Biological Filtration Chemical Filtration Physical Filtration Gravel Hydrometer Ammonia Nitrite nitrate</p> <p>Skills Identify components necessary for a functioning marine aquarium. State that a hydrometer is a tool used to measure the salinity of a marine aquarium. State that the correct pH range for a healthy marine aquarium is 7.5-8.4. Know that conditions must be in appropriate range before organisms may be added to a marine aquarium. Recognize the importance of maintaining water quality in a marine aquarium. Recognize that toxins can accumulate in a marine aquarium and must be managed.</p>	<p>Describe the function of each necessary component of a marine aquarium.</p> <p>Explain how a hydrometer measure specific gravity to determine salinity in a marine aquarium.</p> <p>Test for the correct pH range in a saltwater aquarium (7.5-8.4).</p> <p>List the conditions necessary for introduction of organisms to a marine aquarium.</p> <p>List various methods used to maintain water quality in a marine aquarium.</p> <p>Identify specific toxins that can accumulate in a marine aquarium and explain how you can test for them.</p>	<p>Setup a marine aquarium using the necessary major components: Aquarium, gravel, filtration (biological, chemical and physical).</p> <p>Use a hydrometer for mixing and checking the correct specific gravity of saltwater for the tank.</p> <p>Maintain correct pH range for a saltwater aquarium (7.5-8.4).</p> <p>Know when and how to introduce organisms to the aquarium.</p> <p>Identify the most effective method for maintaining water quality in a saltwater aquarium (water addition, 25% partial water changes, use of activated carbon, general cleaning and algae removal).</p> <p>Identify toxic substances that accumulate in a saltwater aquarium and use different types of test kits to measure levels in the aquarium (ammonia, nitrite and nitrate).</p>	<p>I can set up a marine aquarium using the necessary components.</p> <p>I can use a hydrometer to measure the specific gravity in my aquarium.</p> <p>I can test for and maintain the pH in the proper range in my aquarium.</p> <p>I will introduce new organisms to my aquarium when the conditions are optimal.</p> <p>I can choose and implement the most effective method(s) for maintaining water quality in my aquarium.</p> <p>I can use test kits to measure the ammonia, nitrate and nitrite levels in my aquarium. I can identify toxic substances that may accumulate in my aquarium.</p>	<p>Create a saltwater aquarium set up shopping list.</p> <p>Complete the hydrometer lab which requires proper use of the hydrometer.</p> <p>Use probeware or other methods to measure the pH in an aquarium.</p> <p>Complete a webquest on designing an aquarium.</p> <p>Set up and maintain a healthy marine aquarium.</p>

Unit 2: History and Technology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Throughout history developments in the biological, physical, chemical and geographical fields of science have led to a greater knowledge of the oceans. (History).	<p>Key Terms Civilization Middle Ages Oceanography</p> <p>Skills Knowledge of Charles Darwin and his contributions to science.</p> <p>Identify an instance in history of science in which scientific knowledge has changed when new interpretations are encountered.</p>	<p>Key Terms Theory Chronometer James Cook John Harrison Charles Darwin H.M.S. Challenger</p> <p>Skills Recognize that early civilizations interacted with and relied upon oceans.</p>	<p>Identify James Cook, John Harrison, Charles Darwin and the H.M.S. Challenger as making major contributions to the science of oceanography.</p> <p>Identify the three primary reasons early civilization interacted with the oceans.</p> <p>Identify some contributions from ancient civilizations and the middle ages.</p>	<p>List the three primary reasons early civilization interacted with the oceans.</p> <p>Describe the specific contributions that James Cook, John Harrison, Charles Darwin and the H.M.S. Challenger each made to the science of oceanography.</p>	<p>I can list the three primary reasons early civilization interacted with the oceans.</p> <p>I can describe the contributions that each of the following contributed to the science of oceanography: James Cook John Harrison Charles Darwin H.M.S. Challenger</p>	<p>Create a marine history timeline.</p> <p>Trace the voyage of the H.M.S. Challenger on a world map and list three modern technologies that would have made the exploration more efficient. Explain how these technological improvements impacted the discoveries made.</p>

Unit 2: History and Technology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Throughout history developments in the biological, physical, chemical and geographical fields of science have led to a greater knowledge and explorations of the oceans. (Technology).	<p>Key Terms Technology</p> <p>Skills Identify some forms of technology used by scientists.</p>	<p>Key Terms Submersible Hydrothermal Vents</p> <p>Skills Recognize a submersible. Identify various ocean technologies used to study the ocean.</p>	<p>Identify some of the major submersible vehicles used in ocean exploration.</p> <p>Describe the characteristics of ROV, AUV, electronic navigation, Loran-C, GPS, satellites, SCUBA and aquarium Reef Base in ocean research.</p>	<p>Identify the significant accomplishments of the major submersible vehicles used in ocean exploration.</p> <p>Describe the uses of ROV, AUV, electronic navigation, Loran-C, GPS, satellites, SCUBA and aquarium Reef Base in ocean research.</p>	<p>I can identify the significant accomplishments of the major submersible vehicles used in ocean exploration.</p> <p>I can describe the uses in ocean research for each of the following: ROV AUV Electronic Navigation Loran-C GPS Satellites SCUBA Aquarium Reef Base</p>	<p>Design a remote operating vehicle that completes specified tasks.</p> <p>Follow a set of waypoints around campus using a compass and using GPS. Write your observations comparing these two technologies.</p> <p>Complete a geocache task.</p>

Unit 3: Marine Chemistry

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Without the unique properties of water life on earth would not exist.	<p>Key Terms Salinity Temperature Density Chemical bonding Solvents</p> <p>Skills Basic understanding of chemical bonds. Basic understanding of solvents. Identify properties and common uses of water in each of its states.</p>	<p>Key Terms Universal solvent Hydrogen bonds Polarity Bonding Thermal desalination</p> <p>Skills State that water is able to sustain life. State that salinity and temperature affect density. State that water can be a solvent.</p>	<p>List some properties of water that enable it to sustain life.</p> <p>Correlate temperature and salinity to the density of water.</p> <p>State that water is a universal solvent.</p> <p>Define water polarity.</p> <p>Define Hydrogen bonding in water.</p> <p>State that desalination is a process used to remove salt from water.</p>	<p>Explain how certain properties enable water to sustain life.</p> <p>Explain how salinity and temperature affect the density of water.</p> <p>Describe the polarity and hydrogen bonding capacity of water.</p> <p>Describe the process of desalination.</p> <p>How is water able to be called “the universal solvent?”</p>	<p>I can list properties of water and explain how they enable water to sustain life.</p> <p>I can explain how salinity and temperature affect the density of water.</p> <p>I can describe the polarity and hydrogen bonding capacity of water.</p> <p>I can describe the step by step process of desalination.</p> <p>I can explain why water is called the “universal solvent.”</p>	<p>Short response prompt: Explain how the structure of the water molecule affects its physical and chemical characteristics that allow life to exist on the earth.</p> <p>Explain why ice floats.</p> <p>Write a proposal for a new desalination plant. Include location and complete design of the plant.</p>

Unit 3: Marine Chemistry

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The scientific theory of evolution of Earth states that changes in our planet are driven by the flow of energy and the cycling of matter through dynamic interactions among the atmosphere, hydrosphere, geosphere and biosphere.	Key Terms Carbon Cycle Gasses Biosphere Skills	Key Terms Water Cycle Biosphere Skills Define biosphere. State that water can cycle through the biosphere. State that the carbon cycle is the process by which carbon is moved through the biosphere.	Label a diagram of the water cycling through the biosphere. Label a diagram of the carbon cycle. Identify sources of carbon in the ocean	Explain how water cycles through the biosphere. Relate carbon to dissolved gasses in the ocean and the carbon cycle.	I can explain how water cycles through the biosphere. I can relate carbon dissolved gasses in the ocean and the carbon cycle.	Draw and label the water cycle. Explain how water cycles through the biosphere while referring to the diagram. Using an online animation of the carbon cycle, explain how dissolved gasses relate to the cycle.

Unit 3: Marine Chemistry

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be earned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The unique properties of water affect our climate.	<p>Key Terms Climate Hydrogen Bonding</p> <p>Skills Basic knowledge of hydrogen bonding. Describe the changes water undergoes when it changes state through heating and cooling by using familiar scientific terms such as melting, freezing, boiling, evaporation and condensation.</p>	<p>Key Terms Specific Heat Vaporation</p> <p>Skills Define specific heat. Explain vaporation. Recognize that hydrogen bonding impacts specific heat and high heat of vaporation of water.</p>	<p>Connect hydrogen bonding to specific heat and vaporation of water.</p> <p>State that water has an impact on our climate.</p>	<p>Explain how hydrogen bonding accounts for water’s high specific heat and high heat of vaporation.</p> <p>Explain how water affects our climate.</p>	<p>I can explain how hydrogen bonding accounts for water’s high specific heat and high heat of vaporation.</p> <p>I can explain how water affects our climate. I can provide specific examples.</p>	

Unit 4: Marine Physics

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Waves are the result of a disturbance. They transport energy and momentum but do not transport matter.	<p>Key Terms Wave</p> <p>Skills How to graph data. Understand moon phases.</p>	<p>Key Terms Wave Crest Trough Wavelength Height Tide Spring tide Neap tide Diurnal Semidiurnal Mixed tide</p> <p>Skills Describe the movement of a wave in water. Identify parts of a wave on a diagram. Read and interpret graphs of tide height vs. time.</p>	<p>Label all parts of a wave on a diagram.</p> <p>Relate tides to moon phases.</p> <p>Describe the movement of water in a wave.</p> <p>Graph the changes in tide height vs. time.</p>	<p>Explain the movement of water in a wave. Include all parts of a wave in your explanation.</p> <p>Graph the changes in tide height vs. time to determine the relationship between moon phases, moon positions, and the times of spring and neap tides: diurnal, semidiurnal and mixed.</p>	<p>I can explain the movement of water in a wave. My explanation will include all parts of a wave.</p> <p>When presented with data, I can graph the changes in tide height vs. time. From this I can determine the relationship between moon phases, moon positions, and the times of spring and neap tides, diurnal, semidiurnal and mixed.</p>	<p>Create a screenchomp that explains the movement of water in a wave. Include diagrams and all parts of a wave.</p> <p>Graph tides of different cities and determine the classification of the tides.</p>

Unit 4: Marine Physics

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
<p>What is the programmatic goal to be learned?</p> <p>Energy is involved in all physical and chemical processes. Energy is conserved, and can be transformed from one form to another and into work.</p> <p>Chemical reactions result in the release or absorption of energy. Waves are the propagation of a disturbance. They transport energy and momentum but do not transport matter.</p>	<p>What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?</p> <p>Key Terms Heat Energy Latitude Longitude</p> <p>Skills Recognize that adding heat or removing heat from a system may result in a temperature change and possibly a change in state.</p>	<p>What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?</p> <p>Key Terms Open system Closed system Isolated system Law of conservation of Energy</p> <p>Skills Identify open, closed and isolated systems.</p>	<p>What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?</p> <p>Describe open, closed and isolated systems. Explain the Law of Conservation of Energy.</p>	<p>What is the more complex use of content knowledge or skill required of students to master this goal?</p> <p>Demonstrate the Law of Conservation of Energy in various scenarios of energy transformation.</p>	<p>What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”</p> <p>What you are looking for is a demonstration of the law of conservation of energy when presented with various energy transformation scenarios.</p>	<p>What sample task(s) would provide evidence of a student’s success in each area of progression?</p> <p>Accurate completion of the online learning activity titled “Energy Conservation In A System.”</p>

Unit 4: Marine Physics

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
<p>What is the programmatic goal to be learned?</p>	<p>What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?</p>	<p>What basic terminology, specific facts, or simple ideas are required for students to progress towards mastery of this goal?</p>	<p>What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?</p>	<p>What is the more complex use of content knowledge or skill required of students to master this goal?</p>	<p>What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”</p>	<p>What sample task(s) would provide evidence of a student’s success in each area of progression?</p>
<p>Water has the ability to hold on and store heat then move it from location to location through currents. It also cycles carbon and water through the ecosystem.</p>	<p>Key Terms Heat Climate Hurricane</p> <p>Skills Differentiate between weather and climate.</p>	<p>Key Terms Coriolis effect Heat Capacity</p> <p>Skills State the definition of the Coriolis effect.</p>	<p>Relate ocean surface currents to climate.</p> <p>Describe the circulation patterns of the northern and southern hemisphere (Coriolis effect).</p> <p>Relate ocean currents and heat to the movement of hurricanes.</p>	<p>Explain the concept of heat capacity and the role of the ocean in moderating the earth’s climate.</p> <p>Detail the characteristics and movement patterns of Atlantic hurricanes.</p> <p>Explain the influence of ocean surface currents on climates of coastal regions that border them.</p>	<p>I can explain the concept of heat capacity and the role of the ocean in moderating the earth’s climate.</p> <p>I can provide a detailed account of the characteristics and movement patterns of Atlantic Hurricanes.</p> <p>I can explain how ocean surface currents impact the climates of coastal regions.</p>	<p>Complete the ocean current lab activity.</p> <p>Create a demo to teach the class about the coriolis effect.</p> <p>Using NOAA ad hurricane websites, map a previous Atlantic hurricane. Include the movement patterns and storm characteristics.</p>

Unit 4: Marine Physics

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Severe weather is linked to many different abiotic factors such as temperature, pressure, Coriolis effect and currents.	<p>Key Terms Biotic Abiotic Energy Atmosphere Weather</p> <p>Skills Understand the concept of energy transfer. Differentiate between weather and climate.</p>	<p>Key Terms Temperature Pressure Coriolis effect Currents</p> <p>Skills State that abiotic factors lead to the formation of weather. State that energy can be transferred through the atmosphere.</p>	<p>List some abiotic factors that lead to the formation of weather.</p> <p>State that energy is transferred from the ocean to the atmosphere through the formation of masses and weather systems.</p>	<p>Explain how abiotic factors lead to the formation of weather events. Including thunderstorms and hurricanes.</p> <p>Explain how energy is transferred from the ocean to the atmosphere through the formation of masses and weather systems.</p>	<p>I can list some abiotic factors that can lead to the formation of weather events. I can explain how each factor leads to the formation of weather events. I will include thunderstorms and hurricanes in my explanation.</p> <p>I can explain how energy is transferred from the ocean to the atmosphere through the formation of masses and weather systems.</p>	<p>Storm activity websites? NOAA site? Heat transfer tool online?</p>

Unit 5: Marine Geology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be earned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The scientific theory of plate tectonics provides the framework for much of modern geology.	<p>Key Terms Theory Convergent Divergent Transform</p> <p>Skills The concept of plate boundaries. Explain why theories may be modified but rarely discarded.</p>	<p>Key Terms Crust Mantle Outer Core Inner Core Oceanic Crust Continental Crust Continental drift Seafloor spreading Alfred Wegener Glomar Challenger Sonar</p> <p>Skills Know the inner earth is composed of layers. Be familiar with the theory of plate tectonics. Identify oceanic and continental crust.</p>	<p>Label the earth’s inner layers on a diagram.</p> <p>Compare and contrast oceanic and continental crust.</p> <p>Identify Alfred Wegener as the first to advance the theory of plate tectonics.</p> <p>Explain the theory of continental drift.</p> <p>Explain the theory of seafloor spreading.</p> <p>Identify the Glomar Challenger.</p> <p>Define Sonar and bathymetry.</p> <p>List examples of events at plate boundaries.</p>	<p>Describe the geology of the ocean floor using the theory of plate tectonics. Include continental drift and seafloor spreading.</p> <p>When given a seafloor event or structure identify what type of plate boundary it is associated with.</p> <p>Describe how Alfred Wegener contributed to the theory of plate tectonics.</p> <p>Explain how sonar, bathymetry and the Glomar Challenger all contribute to our understanding of the sea floor.</p>	<p>I can describe the geology of the ocean floor using the theory of plate tectonics. I can include continental drift and seafloor spreading.</p> <p>When given a seafloor event or structure, I can identify what type of plate boundary it is associated with.</p> <p>I can describe how Alfred Wegener contributed to the theory of plate tectonics.</p> <p>I can explain how sonar, bathymetry and the Glomar Challenger all contribute to our understanding of the sea floor.</p>	<p>Short response prompt: How does the theory of plate tectonics explain various geological features on the ocean floor?</p> <p>Accurately complete the layers of the Earth online lab.</p> <p>Complete the “Mountains in the Sea” scenario.</p>

Unit 5: Marine Geology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be earned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Over geologic time, internal and external sources of energy have continuously altered the features of Earth by means of both constructive and destructive sources.p0o	<p>Key Terms Seafloor Geology</p> <p>Skills Understand the theory of plate tectonics and the mechanisms involved.</p>	<p>Key Terms Abyssal plain Continental rise Continental shelf Continental slope Guyot Mid-ocean ridge Rift valley Seamount Trench bathymetry</p> <p>Skills Recognize the seafloor is comprised of various features formed via the mechanisms of plate tectonics.</p>	Identify the following seafloor features on a diagram of the seafloor. Abyssal plain, continental rise, continental shelf, continental slope, guyot, mid-ocean ridge, rift valley, seamount and trench.	Describe the topography of the ocean floor and how the following features formed: Abyssal plain, continental rise, continental shelf, continental slope, guyot, mid-ocean ridge, rift valley, seamount and trench.	I can describe the topography of the ocean floor and how the following features formed: Abyssal plain, continental rise, continental shelf, continental slope, guyot, mid-ocean ridge, rift valley, seamount and trench.	<p>Create a 3 dimensional model of the abyssal plain in the Atlantic ocean.</p> <p>Using the NOAA website-map the ocean floor via bathymetry.</p>

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes. (Trophic Levels).	<p>Key Terms Food Web</p> <p>Skills Food Chains and Food webs.</p>	<p>Key Terms Trophic Level Consumer Producer Decomposer Trophic Pyramid</p> <p>Skills Recognize trophic levels on a marine trophic food pyramid.</p>	<p>Given a marine food we identify the producers, consumers and decomposers.</p> <p>Recognize that energy flows through a marine ecosystem.</p>	<p>Given a marine food web, describe the trophic relationships between the shown organisms.</p> <p>Describe the flow of energy through a marine ecosystem, using the sun, producers, consumers and decomposers.</p> <p>Calculate the reduction of available energy that is transferred from one trophic level to the next using the 10% rule.</p>	<p>Given a marine food web, I can describe the trophic relationships between the shown organisms.</p> <p>I can describe the flow of energy through a marine ecosystem, using the sun, producers, consumers and decomposers.</p> <p>I can calculate the reduction of available energy that is transferred from one trophic level to the next using the 10% rule.</p>	<p>Construct a probable marine trophic pyramid.</p> <p>Using a complete sample marine trophic pyramid, calculate the transfer of energy to each trophic level using the 10% rule.</p> <p>Short response prompt: Why can an ocean ecosystem sustain smaller populations of top level predators than lower trophic level organisms?</p>

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The scientific theory of the evolution of Earth states that changes in our planet are driven by the flow of energy and the cycling of matter through dynamic interactions among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere, and the resources used to sustain human civilization on Earth. (Carbon Cycle).	<p>Key Terms Matter Ecosystem</p> <p>Skills</p>	<p>Key Terms Carbon cycle Nitrogen cycle Water cycle Geochemical cycle Matter</p> <p>Skills Energy and matter flow through an ecosystem.</p>	Geochemical cycles (water, carbon and nitrogen cycles) move energy and matter through an ecosystem.	<p>Diagram and explain the geochemical cycles of an ecosystem, including water, carbon and nitrogen cycle.</p> <p>When presented with an interruption in the carbon cycle, explain how this impacts the ecosystem.</p>	<p>I can diagram and explain the geochemical cycles of an ecosystem, including water, carbon and nitrogen cycle.</p> <p>When presented with an interruption in the carbon cycle, I can explain how this impacts the ecosystem.</p>	Construct a scientific model of the carbon cycle to show how matter and energy are continuously transferred within and between organisms and their physical marine environment.

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes. Human activities and natural events can have profound effects on populations, biodiversity and ecosystem processes. (Marine Zones).	<p>Key Terms Biotic Abiotic Classification</p> <p>Skills How to use the classification system.</p>	<p>Key Terms Photic Aphotic Benthic Pelagic Intertidal Bathyal Abyssal Planktonic Nekton Littoral Sublittoral Neritic Oceanic Phytoplankton Zooplankton</p> <p>Skills The classification system.</p>	<p>Identify the abiotic factors for the marine environmental zones (photic, aphotic, benthic, pelagic, intertidal, bathyal and abyssal).</p> <p>Identify examples of organisms as planktonic, nektonic or benthic.</p>	<p>Label the zones of the marine environment. Describe the abiotic factors of each zone. List examples of organisms that inhabit each zone.</p>	<p>I can label the zones of the marine environment on a diagram. I can describe the abiotic factors of each zone. I can list examples of organisms that inhabit each zone.</p>	<p>Interpret an ocean zone map. Create a list of organisms that could inhabit each zone.</p>

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
<p>What is the programmatic goal to be learned?</p>	<p>What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?</p>	<p>What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?</p>	<p>What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?</p>	<p>What is the more complex use of content knowledge or skill required of students to master this goal?</p>	<p>What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”</p>	<p>What sample task(s) would provide evidence of a student’s success in each area of progression?</p>
<p>The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. Human activities and natural events can have profound effects on populations, biodiversity and ecosystem processes. (Nutrient Zones).</p>	<p>Key Terms Productivity Nutrients Skills</p>	<p>Key Terms Limiting Factor Coastal run-off River input Upwelling</p> <p>Skills Understanding of limiting factors.</p>	<p>List limiting factors to primary productivity in the marine environment.</p> <p>Identify sources of nutrient input into the marine environment (coastal run-off, river input and upwelling).</p> <p>Compare coastal waters vs. the open ocean in terms of abundance.</p>	<p>Explain how various regions of the marine ecosystem acquire nutrients. Describe the overall abundance and productivity of the region and include any limiting factors.</p>	<p>I can explain how various regions of the marine ecosystem acquire nutrients. I can describe the overall abundance and productivity of the region and include any limiting factors.</p>	<p>Complete the run-off and phytoplankton lab activity.</p>

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. Natural events can have profound effects on populations, biodiversity and ecosystem processes. (Carrying Capacity).	<p>Key Terms Limiting Factors Population</p> <p>Skills Understand limiting factors.</p>	<p>Key Terms Carrying capacity Limiting Factors</p> <p>Skills Define Carrying capacity.</p>	<p>Describe the concept of carrying capacity.</p> <p>Explain the relationship between limiting factors and carrying capacity.</p>	Given a region of the marine environment, identify the limiting factors for the region and determine the carrying capacity.	Given a region of the marine environment, I can identify the limiting factors for the region and determine the carrying capacity	Using the aquarium as a model, explain the carrying capacity of this mini ecosystem. Describe any limiting factors for this aquarium ecosystem.

Unit 6: Marine Ecology

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. (Symbiotic Relationships).	<p>Key Terms Competition Cooperation Predator Prey</p> <p>Skills Understand the predator-prey dynamic.</p>	<p>Key Terms Symbiosis Parasitism Mutualism Commensalism</p> <p>Skills Know that various types of relationships and interactions occur among marine organisms.</p>	<p>Distinguish between the symbiotic relationships such as parasitism, commensalism and mutualism.</p> <p>List reasons for competition among marine organisms.</p>	<p>When presented with specific examples, identify the symbiotic relationships such as parasitism, commensalism and mutualism.</p> <p>Provide reasons for competition between marine organisms. Include reproduction, food, space and shelter).</p>	<p>When presented with specific examples, I can identify the symbiotic relationships such as parasitism, commensalism and mutualism.</p> <p>I can provide reasons for competition between marine organisms. I can include reproduction, food, space and shelter.</p>	<p>Complete the organism relationship matching activity.</p> <p>Identify the organisms relationships in your marine aquarium.</p>

Unit 7: Marine Populations

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The scientific theory of evolution by means of natural selection is a fundamental concept underlying all of biology. All organisms change over time because they are locked in a struggle for existence whereby those organisms better adapted to their immediate environment are more likely to survive and leave more offspring.	<p>Key Terms Kingdom Phylum Class Order Family Genus Species</p> <p>Skills Understanding of the classification system. Understanding of adaptations of organisms to their environments. Describe how and why organisms are classified according to shared characteristics.</p>	<p>Key Terms Invertebrate Phaeophyta Chlorophyta Rhodophyta Porifera Cnidaria Ctenophora Mollusca Annelida Arthropoda Echinodermata Agnatha Chondrichthyes Osteichthyes Tetrapod Aves Reptilia Mammalia Pinnipedia Sirenia Cetacea Carnivora Symmetry</p> <p>Skills Recognize some adaptations of marine organisms to their environment.</p>	<p>Identify adaptations to the marine environment for organisms in the Kingdom Protista.</p> <p>Identify adaptations to the marine environment for the invertebrate phyla (Porifera, Cnidaria, Ctenophora, Mollusca, Annelida, Arthropoda, Echinodermata).</p> <p>Identify adaptations to the marine environment for the fish classes (Agnatha, Chondichthyes, Osteichthyes).</p> <p>Identify adaptations to the marine environment for the tetrapod classes (Aves, Reptilia, Mammalia).</p> <p>Identify adaptations to the marine environment for the mammalian orders (Pinnipedia, Sirenia, Cetacea, Carnivora).</p>	Classify marine organisms based on their adaptations to their marine environments.	I can classify marine organisms based on their adaptations to their marine environments.	<p>Complete dissections of the different marine phyla (virtual or real).</p> <p>Classify organisms into distinctive taxonomic categories.</p> <p>Use dichotomous keys to classify various marine organisms.</p>

Unit 8: Marine Environment

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. (Estuaries and mangroves).	<p>Key Terms</p> <p>Biotic Abiotic Salinity Elevation Chemistry Geography Light Depth Temperature Stratification Ecosystem</p> <p>Skills</p> <p>Knowledge of the classification system. Identify biotic and abiotic factors. Differentiate between biological and physical components of an ecosystem. Describe limiting factors in the local ecosystem and their impact on the native populations.</p>	<p>Key Terms</p> <p>Biotic Abiotic Salinity Elevation Chemistry Geography Light Depth Temperature Stratification Ecosystem Estuary Coastal Plain Fjord Bar-build Tectonic Salt Wedge Euryhaline Stenohaline Mangroves Salt Marshes Sea grasses</p> <p>Skills</p> <p>Understand the concept of stratification. Understand the concept of salinity.</p>	<p>Define Estuary. Identify the classification of estuaries using a classification system. Define euryhaline and stenohaline and be able to identify organisms in each. Identify biotic and abiotic factors in mangrove swamps, salt marshes and sea grasses. Identify the three types of mangroves (red, black and white).</p>	<p>Classify an estuary based on origin and stratification. Identify euryhaline and stenohaline organisms and list those that are likely to be found in an estuary. Provide a biological and physical description of mangrove swamps, salt marshes and sea grasses. Identify the three types of mangroves using leaf design, trunk, and root structure and relate each tree to its most frequently found elevation zone.</p>	<p>I can classify an estuary based on origin and stratification. I can identify euryhaline and stenohaline organisms and list those that are likely to be found in an estuary. I can provide a biological and physical description of mangrove swamps, salt marshes and sea grasses. I can identify the three types of mangroves using leaf design, trunk, and root structure and relate each tree to its most frequently found elevation zone.</p>	<p>Identify the types of mangroves on a diagram when provided with leaf design, trunk and root structure. Complete the interactive estuary website. This requires classifying estuaries on origin and stratification. Create a tour brochure of mangrove swamps, salt marshes and sea grasses.</p>

Unit 8: Marine Environment

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. (Coral Reefs).	<p>Key Terms Physical Chemical</p> <p>Skills Understand the factors involved in climate. Describe the limiting factors in the local ecosystem and their impact on the native populations.</p>	<p>Key Terms Coral reef Fringing reef Barrier reef Atoll nutrients salinity</p> <p>Skills Identify chemical and physical factors in a coral reef.</p>	<p>Map the worldwide distribution of coral reefs.</p> <p>List the chemical and physical factors required for coral growth (moderate water motion, clear water, low nutrients, moderately high salinity, plenty of sunlight).</p> <p>Identify the three types of coral reefs.</p>	<p>Explain why corals are more common on the western side of the ocean basin. Include both chemical and physical factors in the explanation.</p> <p>Distinguish between the three types of coral reefs and how they are formed.</p>	<p>I can explain why corals are more common on the western side of the ocean basin. I can include both chemical and physical factors in the explanation.</p> <p>I can distinguish between the three types of coral reefs and how they are formed.</p>	<p>Map out the locations of various coral reefs. Describe the physical and chemical properties of each region.</p> <p>Label a diagram of the three types of coral reefs.</p> <p>Maintain a healthy coral reef aquarium.</p> <p>Report on the reasons for coral reef decline.</p>

Unit 8: Marine Environment

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. (Intertidal Zones).	<p>Key Terms Currents Tides Waves Organism Species Adaptation</p> <p>Skills Identify chemical and physical factors.</p>	<p>Key Terms Intertidal Zone Rocky Shore Sandy Beach</p> <p>Skills Identify physical and chemical factors that affect species distribution on the intertidal zones.</p>	Describe the physical and chemical factors that affect species distribution on the intertidal zones. Include both rocky shores and sandy beaches.	<p>Map out the distribution of various marine species in intertidal zones based on physical and chemical factors.</p> <p>Describe the adaptations of organisms to the physical and chemical factors of all types of intertidal zones. Provide specific adaptations.</p> <p>Compare adaptations of intertidal organisms to the adaptations of organisms in the open ocean.</p>	<p>I can map out the distribution of various marine species in intertidal zones based on physical and chemical factors.</p> <p>I can describe the adaptations of organisms to the physical and chemical factors of all types of intertidal zones. Provide specific adaptations.</p> <p>I can compare adaptations of intertidal organisms to the adaptations of organisms in the open ocean.</p>	<p>While viewing video sequences of various intertidal organisms, identify adaptations.</p> <p>Complete the intertidal exploration scenario.</p> <p>Label a diagram of the intertidal zones, list organisms and their adaptations. List the physical and chemical characteristics of each zone.</p>

Unit 9: Human Impact

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
There are alternatives to using fossil fuels for energy.	<p>Key Terms Energy Fossil Fuel Seafloor</p> <p>Skills Resources currently available in California. Current sources of energy. Understanding that humans have an impact on the earth.</p>	<p>Key Terms Renewable Non-renewable Fossil fuel Energy Algae Seafloor</p> <p>Skills Current sources of energy. Understanding that humans have an impact on the earth.</p>	<p>Identify marine examples of renewable resources and the costs and benefits of their use.</p> <p>Identify marine examples of non-renewable resources and the costs and benefits of their use.</p> <p>List possible impacts resulting from the use of renewable and nonrenewable resources.</p> <p>Identify seafloor resources such as nodules and methane hydrates.</p>	<p>Describe how different natural resources are produced and how their rates of use and renewal limit availability.</p> <p>Evaluate the effects on the environment of renewable and non-renewable resources.</p>	<p>I can describe how different natural resources are produced and how their rates of use and renewal limit availability.</p> <p>I can evaluate the effects on the environment of renewable and non-renewable resources</p>	<p>Create a list of renewable and non-renewable resources in California. List the drawbacks and benefits of each.</p> <p>Create a proposal for a new energy company. Your energy source must be a marine source.</p>

Unit 9: Human Impact

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
<p>The distribution and abundance of organisms is determined by the interactions between organisms and between organisms and the non- living environment.</p> <p>Human activities, natural events, global climate change, and the introduction of invasive, non- native species can have a profound effect on populations, biodiversity and ecosystem processes.</p>	<p>Key Terms Species Biodiversity Wetland Organism Population Ecosystem Overfishing</p> <p>Skills Examples of native species in California. Understanding of natural catastrophic events. The concept of climate change.</p>	<p>Key Terms Non-native species Invasive species</p> <p>Skills The ability to identify marine invasive species. Understand that global climate change has specific impacts on the environment. Identify some natural catastrophic events that affect the marine environment.</p>	<p>Identify marine invasive species and the effects on the ecosystem.</p> <p>Relate global climate change to the marine environment.</p> <p>Describe some examples of natural catastrophic events that affect the marine environments. Provide examples.</p>	<p>Identify marine invasive species and the effects on the ecosystem and modes of introduction. Provide specific examples.</p> <p>Debate the impact of climate change on the marine environment. Provide specific examples to back up your position.</p> <p>Describe some examples of natural catastrophic events that affect the marine environment and what affects they have. Explain specific scenarios.</p>	<p>I can identify marine invasive species and the effects on the ecosystem and modes of introduction. I can provide specific examples.</p> <p>I can debate the impact of climate change on the marine environment. I can provide specific examples to back up your position.</p> <p>I can describe some examples of natural catastrophic events that affect the marine environment and what affects they have. I can explain specific scenarios.</p>	<p>Race for Space (invasive species) Lab.</p> <p>Create a list of catastrophic natural events and the specific environmental impacts of each.</p> <p>Debate climate change and its impact on the marine environment.</p>

Unit 9: Human Impact

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is…” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Human activity has greatly affected the marine environment. Human activities can have a profound effect on populations, biodiversity and ecosystem processes.	<p>Key Terms Pollution Oil Heavy metals Coral reefs Plastics</p> <p>Skills</p>	<p>Key Terms Biomagnification Bioaccumulation Crude Oil Refined Oil Run off Harvesting Eutrophication Coral Reefs Pollution Dredging</p> <p>Skills Understanding of global climate change</p>	<p>Differentiate between biomagnification and bioaccumulation.</p> <p>Differentiate between crude oil and refined oil.</p> <p>Identify causes of coral reef destruction.</p> <p>Identify sources of marine pollution and provide examples.</p> <p>Recognize sources of oil pollution in marine waters.</p> <p>Describe sources of eutrophication.</p> <p>Explain the concept of dredging.</p>	<p>Differentiate between biomagnification and bioaccumulation and describe the effects of each.</p> <p>Differentiate between crude oil and refined oil and explain which is biologically less damaging and why.</p> <p>Identify specific causes of coral reef damage and explain their mechanisms of damage.</p> <p>Identify specific examples of marine pollution and develop solutions to address the examples.</p> <p>List sources of oil pollution in marine waters and develop solutions to address each source.</p> <p>Describe the sources of eutrophication and explain what it can lead to.</p> <p>List the pros and cons of dredging.</p>	<p>I can differentiate between biomagnification and bioaccumulation and describe the effects of each.</p> <p>I can differentiate between crude oil and refined oil and explain which is biologically less damaging and why.</p> <p>I can identify specific causes of coral reef damage and explain their mechanisms of damage.</p> <p>I can identify specific examples of marine pollution and develop solutions to address the examples.</p> <p>I can list sources of oil pollution in marine waters and develop solutions to address each source.</p> <p>I can describe the sources of eutrophication and explain what it can lead to.</p> <p>I can list the pros and cons of dredging.</p>	<p>Choose an oil spill disaster. Research the disaster and its effects. Identify the current status of the surrounding ecosystem. Develop a plan to deal with the environmental damage that has occurred.</p> <p>Complete the oil spill scenario activity.</p>

Unit 9: Human Impact

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Manipulation of DNA in organisms has led to commercial production of biological molecules on a large scale and genetically modified organisms. Mariculture has produced marine products such as food, cosmetics and agriculture.	<p>Key Terms DNA Biotechnology Genetically Modified Organisms</p> <p>Skills</p>	<p>Key Terms Mariculture DNA Biotechnology Genetically Modified Organisms</p> <p>Skills Define the key terms</p>	<p>List ways in which biotechnology has impacted the marine environment (release of GMOs etc.).</p> <p>Know that mariculture produces marine products such as food, cosmetics, pharmaceuticals and agriculture.</p>	<p>Describe specific ways in which biotechnology has impacted the marine environment. Describe the possible negative and positive impacts of each.</p> <p>Explain the process of mariculture and how products are developed from this activity.</p>	<p>I can describe specific ways in which biotechnology has impacted the marine environment. I can describe the possible negative and positive impacts of each.</p> <p>I can explain the process of mariculture and how products are developed from this activity.</p>	<p>Bring in some everyday products that mariculture produces. Share with the class and explain how mariculture played a role in their production.</p> <p>Participate in a debate on the impact of biotechnology on the marine environment.</p>

Unit 9: Human Impact

Programmatic Goal	Prerequisite Skills	Emerging Content	Proficient Content	Advanced Content	Success Criteria	Task Development
What is the programmatic goal to be learned?	What prior knowledge, skills, and/or vocabulary is/are needed for a student to master this goal?	What basic terminology, specific facts, or simply ideas are required for students to progress towards mastery of this goal?	What is the specific target content knowledge or skill required of students to progress towards mastery of this goal?	What is the more complex use of content knowledge or skill required of students to master this goal?	What must a student “look for” in their work or performance to know they have met these expectations? Student can answer “What you’re looking for is...” or “I can”	What sample task(s) would provide evidence of a student’s success in each area of progression?
Human actions affect the ocean and the marine life it holds so we have to create ways to protect it.	<p>Key Terms Marine technology</p> <p>Skills An understanding of the biodiversity of the marine ecosystem.</p> <p>Identify the impact humans have had on earth, such as deforestation, urbanization, desertification, erosion, air and water quality.</p>	<p>Key Terms Methane Hydrates Climatology Pharmaceuticals</p> <p>Skills Recognize marine protected areas.</p>	Identify new technologies and expanding areas of protecting the marine environment such as methane hydrates, marine protected areas, climatology and pharmaceuticals.	Justify the protection of marine life and its environment. Discuss the steps that humans can take to protect the marine ecosystem.	I can justify the protection of marine life and its environment. I can discuss the steps that humans can take to protect the marine ecosystem.	<p>Coral bleaching lab activity.</p> <p>Create a list of 10 simple things you can do to help prevent marine pollution.</p> <p>Follow the seafood watch program. Create a seafood menu based on the watch program recommendations.</p> <p>Create a sample petition to protect a specific region of the marine ecosystem.</p>

How program goals will be addressed:

VII. COURSE OUTLINE

Unit 1: History and Technology

Early civilization and the ocean
Ancient civilizations oceanic contributions
Oceanic contributions during the middle ages
The chronometer
Theory of coral reef formation
James Cook
H.M.S Challenger expedition
Submersible vehicle contributions
Exploration equipment

Unit 2: Aquariums

What is marine biology?
Four branches of oceanography
Marine science careers
Setting up an aquarium
Specific gravity measurement
pH of healthy saltwater
Maintaining aquarium water quality

Unit 3: Marine Chemistry

Water density
Cohesive water property
Universal solvent
Water expansion
Water movement through biosphere
Water and climate

Unit 4: Marine Physics

Parts of a wave
Wave movement within water
Waves and moon phases
Tide tables
Open and closed systems
Heat capacity
Ocean currents
Current and climate
Hurricanes
Weather
Coriolis effect

Unit 5: Marine Geology

Earth Layers
Plate Tectonics
Alfred Wegener
Continental Drift
Seafloor spreading
Bathymetry
Sonar

Plate Boundaries
Ocean floor features

Unit 6: Marine Ecology

Marine energy flow
Marine trophic levels
Biogeochemical cycles
Marine environmental zones
Marine zone organisms
Limiting factors primary productivity
Sources of nutrient input
Abundant marine regions
Ocean species interactions

Unit 7: Marine Populations

Marine species classification
Natural selection
Marine species adaptations
Plant and animal species
Invertebrate and vertebrate species

Unit 8: Marine Environment

Estuaries
Mangrove swamps
Salt Marshes
Sea grasses
Corals
Intertidal zones

Unit 9: Human Impact

Renewable and no-renewable marine resources
Seafloor resources
Tuna industry
Commercial uses of algae
Noninvasive and invasive species in SF bay area
Over fishing
Commercial fishing
Global climate and marine environment
Biomagnification
Bioaccumulation
Marine Pollution
Eutrophication
CFC's
Plastics
Dredging
Marine biotechnology
Mariculture
Marine Technologies

VIII. INSTRUCTIONAL METHODS and/or STRATEGIES

1. Vodcasts (teacher created)
2. GoogleDocs
3. iPads
4. Blogs
5. Experimental projects
6. Game based instruction (gamefication)
7. Actual research opportunities throughout bay area
8. Discussion
9. Group Work
10. Readings
11. Lab Work
12. Project-based Learning
13. Library Research
14. Internet Research
15. Videos
16. CD Rom
17. Field trips
18. Guest speakers
19. Formative and summative assessments
20. Mastery based
21. Live internet hook-up has been arranged with deep sea NOAA research vehicle.

IX. ASSESSMENT

1. Regular written or computer based examinations
2. Frequent quizzes of varying types
3. Comprehensive, summative projects
4. Laboratory practicum- multiple, based on lab experiments, observation (micro and macro)
5. Laboratory reports
6. Rubrics for 21st century skills
7. Rubrics for labs, etc.
8. Vodcasts
9. Assessment based on the principles of gamefication

A. 21st Century Skills (Critical Thinking, Collaboration, Creativity, Risk-Taking, Problem Solving).

The standards and indicators below are targeted learning objectives that will be assessed in the course.

Students will be **effective communicators** who:

- listen objectively with understanding
- speak with clarity of meaning to any audience for a variety of purposes
- read a variety of materials with understanding
- write with clarity of meaning to any audience for a variety of purposes
- use a variety of strategies to communicate information

Students will be **informed thinkers (critical, creative and problem solving)** who:

- identify, define and solve problems
- set criteria and analyse alternatives in making decisions
- use a variety of critical and creative strategies in solving problems and making decisions
- explain their thought processes in arriving at outcomes
- apply problem-solving and decision-making skills to real life situations

Students will be **collaborative workers** who:

- contribute to the achievement of group or team goals

- perform a variety of roles within groups or teams
- acknowledge and respect contributions of others
- reflect on group or team and personal performance

Students will be **self-directed learners** who:

- assess and reflect on their attitudes, skills and behaviours
- set priorities, plan, and take action to accomplish goals
- manage time and resources efficiently
- apply what they learn to other situations
- explore and prepare for academic, extracurricular and career opportunities

Students will be **information processors** who:

- identify, access, gather and evaluate relevant data
- convert data into usable information related to need
- build knowledge by using a variety of information resources and tools including technology

Students will be **risk takers** who:

- Learn through risk taking and initiative

Students will be **responsible members of society** who:

- recognize diverse ethnic, linguistic, cultural and economic backgrounds
- recognize the rules and processes that govern societies
- demonstrate and exercise the skills required to be a contributing member of a society
- apply practices that preserve the safety and health of one's self, others and the environment

4. Suggested Textbook(s), Materials, equipment and resources

Castro, Peter and Huber, Michael. *Marine Biology*, McGraw Hill

Sumich and Dudley, *Laboratory and Investigations in Marine Life*
Marine Science: The Dynamic Ocean

Supplemental: (and for teachers instructional use)

Greene, Thomas. *Marine Science*, Amsco School Pub
 Reed et al., *The Living Ocean*

5. Start-Up Costs

Professional Development:

Not necessary for author of this course proposal. Author is a former marine scientist and has taught marine science for several years. Author has created marine science curriculums for other districts and states.

Facilities:

The facilities that science teachers currently occupy fit with a marine science course offering. No modification in facilities is necessary.

Equipment:

- All glassware needed is currently available in science classrooms.
- All biotech equipment needed is currently available in the department.

Start-Up Costs

- Aquariums (complete set up): 29 gal and 55 gal: \$2500
- Aquarium supplies \$1000
- Marine species (living): \$1000

- Marine Invertebrate Survey set: \$67
- Ocean in a box: \$40
- Preserved mounts of marine specimens: \$300
- Dissection guides: \$60
- Water test kits (salinity, dissolved oxygen, etc.): \$200
- Castro and Huber Textbooks: \$160 x # of students enrolled (?)

On-going costs

- Animals for dissection:
- Squid: \$115 per class
- Perch: \$50 per class
- Shark: \$165 per class
- Seastar: \$40 per class
- Other Consumables: \$500

Guest Speakers:

The cost would be low for guest speakers. Most speakers will provide their time and expertise for free.

\$1,000 for other possible speaker opportunities.

Field Trips:

Many of our trips will be out in the field and are free to access.

\$2,000 for additional trips to aquariums.

Total Start-up: \$5,167.00 (this does not include textbook costs of \$160 per student)

Total annual on-going costs: \$3,870 (this includes field trips and speakers)

6. Requirements Satisfied

A-G “D” Grad Requirement

7. Appendix I : UbD Units

UNIT 1: HISTORY & TECHNOLOGY

Enduring Understanding: Throughout history developments in the biological, physical, chemical and geographical fields of science have led to a greater knowledge and exploration of the oceans.

Essential Questions

- What are the primary reasons why early civilizations interacted with the ocean?
- What contributions did some of the ancient civilizations make?
- During the Middle Ages what were some important contributions?
- Why was the chronometer an important invention to oceanography?
- Who is credited with the Theory of Coral Reef Formation?
- How was James Cook different from other explorers?
- What types of information was collected during the H.M.S. Challenger Expedition?

CA State Standard: Investigation and Experimentation: 1(k): Recognize the cumulative nature of science.

- Identify the three primary reasons for early civilizations to interact with the oceans: (Food, Trade, Discovery)

Recognize the role of creativity in constructing scientific questions, methods and explanations

- Explain the contributions of the following ancient civilizations: Phoenicians - Mediterranean trade routes, Polynesians - primitive mapping and long distance open ocean seafaring, Greeks: Pytheas - latitude via North Star, Eratosthenes - earth circumference
- Explain the contributions of the following civilizations during the Middle Ages: Chinese - compass, Vikings- Leif Eriksson landed in North America, Portuguese- Christopher Columbus

Explain that a scientific theory is the culmination of many scientific investigations drawing together all the current evidence.

- Identify the scientific contributions to oceanography by: James Cook - included scientific studies on voyages, John Harrison - Chronometer, Charles Darwin - Theory of coral reef development, H.M.S. Challenger expedition - first marine science expedition

Extension:

Explain how Charles Darwin's Voyage aboard the HMS Beagle shaped his thinking about the Theory of Evolution Science and the duties and responsibilities of each

Enduring Understanding: Throughout history developments in the biological, physical, chemical and geographical fields of science have led to a greater knowledge and exploration of the oceans.

Essential Questions

- Identify the significance accomplishments of the major submersible vehicles that have been used to study the oceans?
- What are the characteristics of various types of exploration equipment including: ROVs, AUVs, Loran-C, GPS and Satellites?

California State Standard: Investigation and Experimentation: 1(k): Recognize the cumulative nature of science.

- Identify some of the major submersible vehicles used to study the oceans and their accomplishments: Trieste - Challenger Deep, Alvin - hydrothermal vents and Titanic, Johnson Sealink - panoramic view
- Describe the use of ROV, AUV, electronic navigation, and satellites in ocean research: ROV, AUV, Loran-C, GPS, Satellites, SCUBA, Aquarius Reef Base

Extension:

- Create a scale model of a submersible or ROV
- Investigate research and exploration Institutes like Harbor Branch, Woods Hole, & Scripps.

UNIT 2: AQUARIUMS

Enduring Understanding: Marine biology is multi-discipline branch of Earth Science that studies the oceans of the world and the processes within it including biology, chemistry, geology, meteorology, and physics as well as geography.

Essential Questions

- What is Marine Biology?
- What are the four main branches of Oceanography?
- What are some careers in the field of Marine Biology?

California State Standard: Investigation and Experimentation: 1(1): Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

- Compare and contrast Marine Biology to other fields of Science

Describe and explain what characterizes science and its methods.

- Discuss careers that are available in the various branches of Marine Biology and the duties and responsibilities of each

Extension:

Research and compare career and educational opportunities in various branches of Marine Biology

Enduring Understanding: Establishing and maintaining a marine aquarium acts as a model of a natural aquatic system. There are basic elements needed to create a functioning aquarium and effective methods to maintaining the aquarium.

Essential Questions

- Identify and explain the major components in setting up a marine aquarium
How is specific gravity accurately measured in a marine aquarium?
What is the correct pH range to maintain a healthy saltwater aquarium?
- What is the most effective method for maintaining water quality in the saltwater aquarium?
Science?

California State Standard: Ecology: 6(a-e): Stability in the ecosystem is a balance between competing effects.

California State Standard: Energy in the Earth's System: d: Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of the horizontal and vertical ocean currents, and the geographic distribution of marine organisms.

- Setup a marine aquarium using the necessary major components: Aquarium, Gravel, Filtration, Biological, Mechanical, Chemical
- Know to introduce organisms once nitrite levels decrease
- Use a hydrometer for mixing and checking the correct specific gravity of saltwater for the tank.
- Maintain correct pH range for salt water aquarium (7.5-8.4)
- Identify the most effective method for maintaining water quality in a saltwater aquarium: (Freshwater addition to replace evaporated water, 25% partial water changes, Use of activated carbon, General cleaning of tank and filter to remove algae and waste)

Extension:

Setup a practical lab to diagnose and treat tanks that have varying levels of salinity, pH, Nitrate and mechanical issues with filters.

Enduring Understanding: As in a natural aquatic system, a healthy aquarium requires biological, physical and chemical cycles to occur.

Essential Questions

- Identify and explain the major components in setting up a marine aquarium
- How is specific gravity accurately measured in a marine aquarium?
- What is the correct pH range to maintain a healthy saltwater aquarium?
- What is the most effective method for maintaining water quality in the saltwater aquarium?

California State Standard: Ecology: 6(d): Students know how water, carbon and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

Identify toxic substances that accumulate in a saltwater aquariums and use different types of test kits to measure levels in the aquarium: (Ammonia, Nitrite, and Nitrate)

Extension:

Explain the functions of Nitrosomonas and Nitrobacter bacteria found in the substrate of a saltwater aquarium by converting NH_3^+ to NO_2^- and then NO_3^-

UNIT 3: MARINE CHEMISTRY

Enduring Understanding: Life would not exist without the unique properties of water.

Essential Questions

- What factors affect the density of water?
- How is the density of water important to life on Earth
- Why is the cohesive property of water important to life on Earth?
- Why does water expand when frozen?
- Why is water considered the “universal solvent”?

California State Standard: Solutions: 6 (c): Students know temperature, pressure, and surface area affect the dissolving process.

- Students will understand how salinity and temperature affect the density of water
- Students will identify examples of water’s properties that sustain life
- Students will be able to determine why ice floats
- Students will understand polarity of water and hydrogen bonding capacity
- Students will understand how water affects other substances
- Students can describe the thermal properties of sea water
- Students will understand seawater consists of water and dissolved solids.
- Students will describe the process of desalination.

- How are salt and minerals added to seawater?
- How are minerals and salts removed from seawater?

Extension:

- Students will understand how we can separate dissolved solutes and add solutes to sea water
- Students will differentiate between costs and benefits of desalination

Enduring Understanding: The scientific theory of the evolution of Earth states that changes in our planet are driven by the flow of energy and the cycling of matter through dynamic interactions among the atmosphere, hydrosphere, geosphere, and biosphere.

- Essential Questions
- California State Standard: Ecology: 6(d): Students know how water, carbon and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.*
- How does water move through the biosphere?
 - Students will be able to explain how water cycles through the biosphere
 - Students will be able to related carbon to dissolved gasses in the ocean and the carbon cycle.

Enduring Understanding: The properties of water affect our climate.

Essential Questions	<i>Summarize the conditions that contribute to the climate of geographical area, including the relationships to lakes and oceans.</i>
<ul style="list-style-type: none"> • How are oceans responsible for global climate and local weather? 	<ul style="list-style-type: none"> • Students will be able to explain how hydrogen bonding accounts for water’s high specific heat and high heat of vaporization
<ul style="list-style-type: none"> • How would I calculate the specific heat of seawater? • How do you determine the freezing point of seawater versus freshwater? 	<p>Extension:</p> <ul style="list-style-type: none"> • Students will calculate the specific heat of various salinity levels of water . • Students will determine the freezing point of seawater versus freshwater.

UNIT 4: MARINE PHYSICS

Enduring Understanding: Waves are the result of a disturbance. They transport energy and momentum but do not transport matter.

Essential Questions	<i>California State Standard: Waves: 4(a): Students know waves carry energy from one place to another.</i>
<ul style="list-style-type: none"> • What are the parts of a wave? • How does a wave move within water? • How is wave behavior influenced by water depth? • In what way could you apply your knowledge of wave to a relationship with moon phases? • How can you use tide 	<p><i>4(c): Students know how to solve problems involving wavelength, frequency and wave speed.</i></p> <p><i>Describe the measureable properties of waves and explain the relationships among them.</i></p> <ul style="list-style-type: none"> • Describe the movement of water in a wave • Label the parts of a wave – crest, trough, wavelength and height • Graph the changes in tide height vs. time to determine the relationship between moon phases, moon positions and the times of spring and neap tides: Diurnal, Semidiurnal and Mixed <p>Extension</p> <ul style="list-style-type: none"> • Students will explain tidal areas. • Students will calculate Wave frequency (frequency = velocity / wavelength)

<p>tables to calculate tides?</p>	<ul style="list-style-type: none"> • Students will distinguish between different types of waves such as breakers, deep water, shallow water, Tsunamis
<p>Enduring Understanding: Energy is involved in all physical and chemical processes. It is conserved, and can be transformed from one form to another and into work. Chemical reactions result in the release or absorption of energy. Waves are the propagation of a disturbance.</p>	
<p>Essential Questions</p> <ul style="list-style-type: none"> • What is an open system, closed system and isolated system? • How would you describe the Law of Conservation of Energy? • How is heat transferred through water? • How would you describe the amount of energy input on output within a system based on latitude and longitude? 	<p><i>California State Standard: Conservation of Energy and Momentum: 2: The Laws of Conservation of energy and momentum provide a way to predict and describe the movement of objects.</i></p> <p><i>Explore the Law of Conservation of Energy by differentiating among open, closed, and isolated systems and explain that the total energy in an isolated system is a conserved quantity.</i></p> <ul style="list-style-type: none"> • Differentiate between open, closed and isolated systems • Demonstrate the Law of Conservation of Energy in various scenarios of energy transformation <p><u>Extension</u></p> <ul style="list-style-type: none"> • Students will analyze, based on latitude and longitude, the amount of energy input and output. • Students will describe heat transfer through water.

<p>Enduring Understanding: Water has the ability to hold and store heat then move it from location to location through currents. It also cycles carbon and water through the ecosystem.</p>	
<p>Essential Questions</p> <ul style="list-style-type: none"> • What is heat capacity? • What are the major ocean currents? • How do these ocean currents influence climate? • How is the movement of Atlantic hurricanes related to ocean currents and heat? • What are the major characteristics of surface currents? • What are the major characteristics of deep ocean currents? 	<p><i>California State Standard: Heat and Thermodynamics:3(a): Heat flow and work are two forms of energy transfer between systems.</i></p> <p><i>3(c): Students know the internal energy of an object includes the energy of random motion of the object’s atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up that object.</i></p> <p><i>California State Standard: Energy in the Earth System: 5(a): Students know how differential heating of earth’s results in circulation patterns in the atmosphere and oceans that globally distribute the heat.</i></p> <p><i>5(b): Students know the relationship between the rotation of the earth and the circular motions of ocean currents and air in pressure centers.</i></p> <p><i>5(c): Students know the origin and effects of temperature inversion.</i></p> <p><i>6(f): Students know the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rainforests and deserts.</i></p> <p><i>6(g): Students know features of the ENSO (El Nino Southern Oscillation) cycle in terms of sea-surface and air temperature variations across the pacific and some climatic results of this cycle.</i></p>

	<p><i>The ocean has had a significant influence on climate change by absorbing, storing and moving heat, carbon and water.</i></p> <ul style="list-style-type: none"> • Explain the concept of heat capacity and the role of the ocean in moderating Earth’s climate • Identify the influence of major ocean surface currents on climates of coastal regions that border them (Gulf stream, Peru, California) gulf stream carries heat, California carries cool water • Describe the general circulation patterns of the northern hemisphere and the southern hemisphere (Coriolis Effect) • Detail the characteristics and movement patterns of Atlantic hurricanes <p><u>Extension</u></p> <ul style="list-style-type: none"> • Students will explain and list all surface currents • Student can explain what makes a deep ocean current • Students can distinguish between deep and surface currents
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Enduring Understanding: Severe weather is linked to many different abiotic factors such as temperature, pressure, and currents.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are the abiotic factors that lead to the formation of weather? • How is energy transferred through the atmosphere? 	<p><i>California State Standard: Energy in the Earth System: 6(g): Students know features of the ENSO (El Nino Southern Oscillation) cycle in terms of sea-surface and air temperature variations across the pacific and some climatic results of this cycle.</i></p> <p><i>Climate: 7(a): Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.</i></p> <p>Relate the formation of severe weather to the various physical factors.</p> <ul style="list-style-type: none"> • Describe abiotic factors • Describe the factors that lead to the formation of weather events, including thunderstorms and hurricanes • Explain how energy is transferred from the ocean to the atmosphere through the formation of masses and weather systems <p><u>Extension</u></p> <ul style="list-style-type: none"> • Explain the formation of air masses
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UNIT 5: MARINE GEOLOGY

Enduring Understanding: The scientific theory of plate tectonics provides the framework for much of modern geology.

<p>Essential Questions</p>	<p><i>California State Standard: Dynamic Earth Processes: 3(a): Students know features of the ocean floor(magnetic patterns, age, and sea-floor topography)</i></p>
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<ul style="list-style-type: none"> • What are the Earth’s internal layers? • What is the difference between oceanic and continental crust? • What is the theory of plate tectonics? • Who is Alfred Wegener and why did people not accept his theory? • What evidence supports the Theory of Continental Drift? • What is seafloor spreading?(1 day) • What evidence supports seafloor spreading? • What are bathymetry and sonar? • What happens at convergent, divergent, and transform plate boundaries? • What is the topography of the ocean floor? 	<p><i>provide evidence of plate tectonics.</i> <i>3(b): Students know the principal structures that form at three different kinds of plate boundaries.</i></p> <p><i>Analyze the scientific theory of plate tectonics and identify related major processes and features as a result of moving plates.</i></p> <p><i>Describe the Earth’s internal layers:</i></p> <ul style="list-style-type: none"> • Crust • Mantle (lithosphere and asthenosphere) • Outer core • Inner core • Compare and contrast oceanic crust and continental crust and describe how they interact. • Identify Alfred Wegener as the first to advance the idea of moving continents. • Explain why people did not readily accept his theory. • Explain how the Theory of Continental Drift is supported by evidence. • Explain the theory of seafloor spreading. • Describe evidence that supports seafloor spreading • Include how the Glomar Challenger collected evidence to support seafloor spreading. • Describe how the invention of sonar contributed to an advanced knowledge of the ocean bottom. • Explain what happens at convergent, divergent, and transform plate boundaries. <p><u>Extension:</u></p> <ul style="list-style-type: none"> • Using plate tectonics explain some of the theories for how the earth might be structured in the future.
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Enduring Understanding: Over geologic time, internal and external sources of energy have continuously altered the features of Earth by means of both constructive and destructive forces.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are some ocean floor features and how are they formed? 	<p><i>California State Standard: Dynamic Earth Processes: 3(a): Students know features of the ocean floor(magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.</i> <i>3(b): Students know the principal structures that form at three different kinds of plate boundaries.</i></p> <p><i>Describe the geologic development of the present day oceans and identify commonly found features.</i></p> <ul style="list-style-type: none"> • Identify the following ocean floor features and explain how each is formed: • Abyssal plain
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	<ul style="list-style-type: none"> • Continental rise • Continental shelf • Continental slope • Guyot • Mid-ocean ridge • Rift valley • Seamount • Trench <p><u>Extension:</u></p> <ul style="list-style-type: none"> • Identify the four types of sediments based on origin: • Lithogenous • Biogenous • Hydrogenous • Cosmogenous
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UNIT 6: MARINE ECOLOGY

Enduring Understanding: Energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are the trophic levels in a marine food web? • How does energy flow through the marine ecosystem? • What is the available energy transferred from one trophic level to another in a trophic pyramid? 	<p><i>California State Standard: Ecology: 6(f): Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.</i></p> <p><i>Use a food web to identify and distinguish producers, consumers and decomposers. Explain the pathway of energy transfer through trophic levels and the 10% rule.</i></p> <ul style="list-style-type: none"> • Given a marine food web, describe the trophic relationships between the shown organisms. • Describe the flow of energy through an ecosystem using the sun, producers, consumers and decomposers. • Explain the reduction of available energy that is transferred from one trophic level to the next in a trophic pyramid. (10% rule) <p><u>Extension:</u></p> <ul style="list-style-type: none"> • Describe the different feeding strategies found in the marine environment (suspension feeding, deposit feeding, carnivorous feeding).
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Enduring Understanding: The scientific theory of the evolution of Earth states that changes in our planet are driven by the flow of energy and the cycling of matter through dynamic interactions among the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere, and the resources used to sustain human civilization on Earth.

Essential Questions

- What is the carbon cycle?

California State Standard: Ecology: 6(d): Students know how water, carbon and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon and nitrogen cycle.

- Describe and diagram the carbon cycle.

Enduring Understanding: Energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes. Human activities and natural events can have profound effects on populations, biodiversity and ecosystem processes.

Essential Questions

- What are the abiotic factors for the following areas of the marine environmental zones: photic, aphotic, benthic, pelagic, intertidal, bathyal and abyssal?
- How are plankton, nekton and benthic organisms different from each other?

Characterize the biotic and abiotic components that define freshwater systems, marine systems and terrestrial systems.

- Describe the abiotic factors and label the following areas of the marine environment: photic/aphotic, benthic/pelagic, neritic/oceanic, intertidal(littoral)/sublittoral/bathyal/abyssal zones.
- Classify and give examples of organisms as planktonic (phytoplankton and zooplankton), nektonic, or benthic.

Extension:

- Describe the abiotic factors and label the following areas of the marine environment: epipelagic, mesopelagic, bathypelagic, abyssopelagic, hadalpelagic
- Identify the major factor in distinguishing between the photic and aphotic zones and understand that the euphotic zone is the most productive.
- Classify plankton based on their size and portion of lifetime spent as plankton.

Enduring Understanding The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. Human activities and natural events can have profound effects on populations, biodiversity and ecosystem processes.

Essential Questions

- What is a limiting factor?
- What are three limiting factors for primary productivity?

Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity and temperature.

- Understand the term limiting factor and be able to list three limiting factors to primary productivity.
- Describe the sources of nutrient input into the marine environment.

<ul style="list-style-type: none"> • What are the sources of nutrient input in the marine environment? • Where is the marine life most abundant and why? 	<p>(coastal run-off, river input and upwelling)</p> <ul style="list-style-type: none"> • Explain why marine life is more abundant in coastal waters as compared to the open ocean. <p>Extension:</p> <ul style="list-style-type: none"> • Define the compensation depth for photosynthesis and describe how it is measured.
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Enduring Understanding The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. Natural events can have profound effects on populations, biodiversity and ecosystem processes.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What is carrying capacity? • How are limiting factors and carrying capacity related? 	<p><i>California State Standard: Ecology: (c): Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration and death.</i></p> <p><i>Discuss the characteristics of populations, such as number of individuals, age structure, density, and pattern of distribution.</i></p> <ul style="list-style-type: none"> • Describe the concept of carrying capacity. • Explain the relationship between limiting factors and carrying capacity. <p>Extension:</p> <ul style="list-style-type: none"> • Calculate population density (number of individuals/area)
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Enduring Understanding The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are parasitism, commensalisms, and mutualisms? • Why is there competition between organisms? 	<p><i>Compare and contrast the relationships among organisms, including predation, parasitism, competition, commensalism and mutualism.</i></p> <ul style="list-style-type: none"> • Distinguish between the symbiotic relationships such as parasitism, commensalisms and mutualism and give specific examples. • Give reasons for competition between organisms. (reproduction, food, space, shelter) <p>Extension:</p> <ul style="list-style-type: none"> • Explain how competition affects carrying capacity.
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UNIT 7: MARINE POPULATIONS

Enduring Understanding: The scientific theory of evolution by means of natural selection is a fundamental concept underlying all of biology. All organisms change over time because they are locked in a struggle for existence whereby those organisms better adapted to their immediate environment are more likely to survive and leave more offspring.

Essential Questions

- How are protists adapted to the marine environment?
- How are the different invertebrate phyla adapted to the marine environment?
- How are the different fish classes adapted to the marine environment?
- How are the different tetrapod classes adapted to the marine environment?
- How are the different mammalian orders adapted to the marine environment?
- How are the different mammalian orders adapted to the marine environment?

California State Standard: Ecology: 6(g): Students know how to distinguish between accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

Evolution: 8(a): Students know how natural selection determines the differential survival of groups of organisms.

8(b): Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.

Describe the conditions required for natural selection, including, overproduction of offspring, inherited variation and the struggle to survive which result in differential reproductive success.

Explain the adaptations to the marine environment for the following divisions in Kingdom Protista: (different colors are caused by different pigments)

- A. Phaeophyta: stipe, thallus, blade, holdfast, pneumatocysts
- B. Chlorophyta: evolved into terrestrial plants
- C. Rhodophyta: deepest

Give examples and explain the adaptations to the marine environment of the following invertebrate phyla:

- A. Porifera: asymmetry, sessile, filter feeder, reproduction, spicules, toxins
- B. Cnidaria: cnidocytes/stinging cells, tentacles, polyp, medusa
- C. Ctenophora: radial symmetry and cilia
- D. Mollusca: shell, mantle, foot, radula
- E. Annelida: segmented, bilateral symmetry
- F. Arthropoda: jointed appendages, exoskeleton, molting
- G. Echinodermata: radial symmetry, water vascular system, tube feet, regeneration

Give examples and explain the adaptations to the marine environment of the following Fish classes: Agnatha, Chondrichthyes, and Osteichthyes.

- A. Sensory systems
- B. Buoyancy and energy saving techniques(skeleton, liver, body shape)
- C. Fins, mouths and Body shapes
- D. Reproductive strategies

Give examples and explain the adaptations to the marine environment of the following tetrapod classes:

- A. Aves: waterproof feathers, web feet, eating strategies, salt excretion, endothermic, migration
- B. Reptilia: scales, salt excretion, migrations, terrestrial egg laying, ectothermic
- C. Mammalia: insulation, feeding strategies, migration

Give examples and explain the adaptations to the marine environment of the following mammalian orders:

- A. Pinnipedia: flippers, delayed implantation, body shape
- B. Sirenia: flippers, herbivores
- C. Cetacea: echolocation, dive reflex, myoglobin, body shapes
- D. Carnivora.

Extension:

- Give examples and explain the adaptations to the marine environment for the following divisions in Kingdom Protista: Cyanobacteria, Dinophyta, and Bacillariophyta. (buoyancy, pigments, reproduction, movement)
- Explain the adaptations to the marine environment of the following Cetacea sub-orders: Odonticeti and Mysticeti.

UNIT 8: MARINE ENVIRONMENT

Enduring Understanding: The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and abiotic factors in the environment.

Essential Questions

- What is an Estuary?
- What are the four types of estuaries based on their origin?
- What are the four types of estuaries based on salinity?
- Where are euryhaline and stenohaline organisms more likely to be found in an estuary?
- What are the physical and biological components of mangrove swamps, salt marshes and sea grasses?
- What are the differences between red, black and white mangroves?
- Why are red, black, white mangroves found at different elevations?

California State Standard: Energy in Earth System: 5(d): Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical currents, and the geographic distribution of marine organisms.

Explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity and temperature.

- Define Estuary.
- Describe the classification system of estuaries based on their origin (coastal plain, Fjord, bar-build, tectonic).
- Describe the stratification of an estuary as vertically mixed, slightly stratified, highly stratified, or salt wedge.
- Explain where euryhaline and stenohaline organisms are more likely to be found in an estuary.
- Describe the abiotic and biotic factors of the following coastal ecosystems:
 - Mangrove swamps
 - Salt marshes
 - Sea grasses
- Identify the three mangrove trees (red, black, white) by leaf design, trunk, and root structure and relate each tree to its most frequently found elevation zone.

Enduring Understanding: The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the abiotic environment.

Essential Questions

- Where are corals more likely to be found on Earth?
- Why are corals more common on the western side of the ocean?
- What physical and chemical factors are required for coral growth?
- Explain how the three types of coral reefs are

California State Standard: Ecology: 6(b): Students know to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of non-native species, or population size.

Describe changes in ecosystem resulting from seasonal variations, climate and succession.

- Discuss the worldwide distribution of corals.
- Explain why corals more common on the western side of an ocean basin?
- List the physical and chemical factors required for coral growth. (moderate water motion, clear water, low nutrients, moderately high salinity, plenty of sunlight)

formed?	<ul style="list-style-type: none"> • Distinguish between the three general types of coral reefs and how they are formed. (Fringing reefs, Barrier reefs, Atolls) <p><u>Extensions:</u></p> <ul style="list-style-type: none"> • Describe the physical and chemical environment of the polar oceans including the seasonal variations, salinity, temperature, and currents. • Discuss adaptations of common organisms found in the polar oceans.
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Enduring Understanding: The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the abiotic environment.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are the physical and chemical factors that affect organisms in intertidal zones? • What are the adaptations of an organism to the intertidal zone? 	<p><i>California State Standard: Energy in Earth System: 5(d): Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical currents, and the geographic distribution of marine organisms.</i></p> <p><i>Ecology: 6(a): Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.</i></p> <p><i>Discuss how various oceanic and freshwater processes, such as currents, tides and waves, affect the abundance of aquatic organisms.</i></p> <ul style="list-style-type: none"> • Discuss the physical and chemical factors that affect species distribution on the intertidal zones such as rocky shore and sandy beaches. • Describe adaptations of organisms to the physical and chemical factors of the intertidal zones. <p><u>Extensions:</u></p> <ul style="list-style-type: none"> • Define meiofauna, describe where meiofauna are found in the sediments, and give examples of organisms that comprise the meiofauna. • Describe the physical and chemical environment of the deep ocean including the salinity, temperature, currents, sediment load, and pressure. • Discuss adaptations of common organisms found in the deep oceans. • Describe the physical and chemical environment of the open oceans including the salinity, temperature, and currents. • Discuss adaptations of common organisms found in the open oceans.
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UNIT 9: HUMAN IMPACT

Enduring Understanding: There are alternatives to using fossil fuels for energy.

Essential Questions

- Define renewable and non-renewable resources.
- Give examples of each.
- What are the costs and benefits of each type of resource, including environmental impacts?
- Why did consumers boycott tuna?
- List ways algae is used commercially.
- Give examples of seafloor resources.

California State Standard: California Geology: 9(a): Students know the resources of major economic importance in California and their relation to California's geology.

Evaluate the cost and benefits of renewable and non-renewable resources, such as water, energy fossil fuels, wildlife and forests.

- Identify marine examples of renewable resources and the costs and benefits of their use
- Identify marine examples of nonrenewable resources and the costs and benefits of their use
- Evaluate the possible environmental impacts resulting ~from the use of renewable and/or nonrenewable resources
- Show how consumer and environmental pressures successfully reduced dolphin by-catch in the tuna fishery.
- Describe how algae is used commercially
- Identify seafloor resources (nodules and methane hydrates)

Extensions:

- Describe how human population size and resource use relate to environment quality
- Describe how different natural resources are produced and how their rates of use and renewal limit availability.
- Analyze past, present and potential future consequences to the environment resulting from various energy production technologies.
- Describe alternative sources of energy including but not limited to: wind, solar, tidal, hydroelectric, geothermal, and hydrogen cells and how their rates of use and renewal limit availability.
- Evaluate the effects on the environment of alternative sources of energy including but not limited to: wind, solar, tidal, hydroelectric, geothermal, and hydrogen cells.
- Identify the sources of thermal pollution and its effects
- Explain the process of desalinization

Enduring Understanding: The distribution and abundance of organisms is determined by the interactions between organisms, and between organisms and the non-living environment. Human activities, natural events, global climate change, and the introduction of invasive, non-native species can have a profound effect on populations, biodiversity and ecosystem processes.

Essential Questions

- What is a non-native species? When does it become invasive?

California State Standard: California Geology: 9(a): Students know the resources of major economic importance in California and their relation to California's geology.

<p>What are marine, non-native species that have invaded the San Francisco bay area?</p> <ul style="list-style-type: none"> • How are invasive species introduced into the marine environment and their effects? • How does overfishing create a loss of biodiversity? • What are methods of commercial fishing? • How is global climate change related to marine science? • What are examples of catastrophic events and wetland destruction that can cause a loss of biodiversity? 	<p><i>Ecology: 6(a): Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.</i></p> <p><i>Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.</i></p> <ul style="list-style-type: none"> • Identify marine invasive species, their effects on the marine ecosystems and their modes of introduction. (Asian clam, green mussels, lionfish, pink jellyfish, Brazilian pepper, Australian Pine,) • Define overfishing in terms of maximum sustainable yield. • Give examples of overfished stocks. (cod, tuna, sharks, grouper) • Identify methods of commercial fishing and their impact on the world's oceans. (long lines, drift nets, trawling, purse seines, gill nets) • Identify reasons for the collapse of the whaling industry, reasons for the moratorium, and examples of countries/cultures that still whale • Relate global climate change to the marine environment. (coral bleaching, rising sea levels, increase CO₂, increase algal blooms) • Analyze ways in which humans have caused worldwide wetland destruction • Describe examples of natural catastrophic events that affect the marine environment such as tsunamis, volcanic eruption, methane hydrate eruptions, and earthquakes and what affects they have.
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Enduring Understanding: Human activity has greatly affected the marine environment. Human activities can have a profound effect on populations, biodiversity and ecosystem processes.

<p>Essential Questions</p> <ul style="list-style-type: none"> • Compare biomagnification and bioaccumulation. • What is the greatest source of marine pollution? • What are sources of oil and heavy metal pollution in marine waters? • Why is crude oil less biologically damaging to the marine environment? • List ways coral reefs are destroyed. • What are the sources of eutrophication and what does it lead to? • How are chlorinated hydrocarbons and 	<p><i>California State Standard: Investigation and Experimentation: 1(l): Analyze situations and solve problems that require combining and applying concepts from more than one area of science.</i></p> <p><i>1(m): Investigate a science-based societal issue by researching literature, analyzing data, and communicating the findings.</i></p> <p><i>Discuss the large scale environmental impacts resulting from human activity, including waste pills, oil spills, runoff, greenhouse gases, ozone depletion and surface and groundwater pollution.</i></p> <ul style="list-style-type: none"> • Differentiate between biomagnification and bioaccumulation and their effects. • Identify sources of marine pollution. (agricultural and municipal runoff, airborne emissions, spills/dumping) • Identify the sources of heavy metal pollution in the marine environment. (coal burning, etc.) • Recognize sources of oil pollution in marine waters. • Differentiate between crude and refined oil and which is less biologically damaging. • Identify the causes of coral reef destruction. (runoff, harvesting, global
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<p>plastics dangerous to marine organisms?</p> <ul style="list-style-type: none"> • What are the pros and cons of dredging? 	<p>climate change, boats)</p> <ul style="list-style-type: none"> • Describe the sources of eutrophication and what it can lead to. • Identify reasons why plastics are an environmental threat. • Recognize the dangers of chlorinated hydrocarbons and why they are so dangerous to the marine ecosystem. • List the pros and cons of dredging.
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Enduring Understanding: Manipulation of DNA in organisms has led to commercial production of biological molecules on a large scale and genetically modified organisms. Mariculture has produced marine products such as food, cosmetics, and agriculture.

<p>Essential Questions</p> <ul style="list-style-type: none"> • What are the possible positive and negative impacts of biotechnology on the environment? 	<p><i>California State Standard: Genetics: 6(c): Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.</i></p> <p><i>California State Standard: Investigation and Experimentation: 1(l): Analyze situations and solve problems that require combining and applying concepts from more than one area of science.</i></p> <p><i>1(m): Investigate a science-based societal issue by researching literature, analyzing data, and communicating the findings.</i></p> <p><i>Evaluate the impact on biotechnology on the individual, society and the environment, including medical and ethical issues.</i></p> <ul style="list-style-type: none"> • Identify ways that biotechnology has impacted the environments such as farming techniques and release of genetically modified organisms. (Mariculture produces marine products such as food, cosmetics, pharmaceuticals and agriculture.)
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Enduring Understanding: Human actions affect the ocean and the marine life it holds so we have to create ways to protect it.

<p>Essential Questions</p> <ul style="list-style-type: none"> • List new technology in marine science. • How are the new technologies helping to protect the marine environment? 	<p><i>California State Standard: Investigation and Experimentation: 1(l): Analyze situations and solve problems that require combining and applying concepts from more than one area of science.</i></p> <p><i>1(m): Investigate a science-based societal issue by researching literature, analyzing data, and communicating the findings.</i></p> <p><i>Assess the effectiveness of innovative methods of protecting the environment.</i></p> <ul style="list-style-type: none"> • Identify new technology and expanding areas of marine research such as methane hydrates, marine protected areas, climatology, pharmaceuticals, and animal tracking.
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8. Appendix II

a. Sample Lesson: Attached

b. Sample Assessment: Attached

SAMPLE LESSON #1
Marine Biology
Tamalpais High School
Ms. Tucker

Defining Success	Marine Biology	
	Waves	
	OBJECTIVE: What will your students will be able to do by the end of class? Identify reflection, refraction, and diffraction of waves, and will understand how these concepts are used to help humans in everyday life.	
	ASSESSMENT: How will you know concretely that all of your students have mastered the objective?	KEY POINTS. What three to five main ideas or steps will you emphasize in your lesson?
	Students will complete a lab worksheet with questions and concepts will be incorporated into focus assessment tests. Students will be required to provide a verbal response to questions.	<ol style="list-style-type: none"> 1) reflection 2) refraction 3) diffraction 4) electromagnetic waves

Learning Cycle	INVITATION: How will you focus, prepare and engage students for the lesson's objective? What questions will students answer? What observations will be made?	MATERIALS:
	The class will read a comic that introduces the concepts of waves.	DEMOS:
	EXPLORATION: How will students engage in open-ended exploration of real phenomena, discussion about their discoveries, ideas, and questions that arise?	<ol style="list-style-type: none"> 1) speaker/stereo system 2) corn starch 3) saran wrap 4) iPod 5) long rope 6) low-light video camera 7) infrared light 8) computer/monitor 9) x-ray image 10) underwater images
	Multiple photographs, demos and videos will be used to demonstrate basic concepts relating to waves (amplitude, frequency, and wavelength). 1) A large speaker with corn starch/water on it will be used to visualize various frequency sound waves, and then the volume will be adjusted to see amplitude change. 2) students will participate in a demo when a rope is used to create transverse waves, and then constructive and destructive interference will be demonstrated. 3) students will watch a short video about constructive interference of waves created for wakeboarding. 4) A video camera and infrared light will be used to demonstrate the presence of electromagnetic waves with long wavelengths that we can't see. 5) An x-ray image will be used to discuss high energy electromagnetic waves.	Student Activity:
	CONCEPT INTRODUCTION: How will you convey the knowledge and/or skills of the lesson? What will your students do to process this information?	<ol style="list-style-type: none"> 11) lamps (one per group) 12) Mirror (one per group) 13) Index cards (1 per student) 14) Protractor (1 per group) 15) AA batteries (dead) (1 per group) 16) Prism (1 per group) 17) 250ml Beaker (1 per group) 18) pencil (1 per group) 19) Cardboard with narrow slit (1 per group) 20) Ruler (1 per group) 21) Tupperware tray (1 per group) 22) Eye dropper (1 per group)
	Each demo will be followed up by questions that relate to the key points above. Vodcast. Students will view a vodcast of all concepts for homework. To ensure compliance, students are required to take notes and then respond to GoogleDoc questions about the vodcast content.	
	APPLICATION: In what ways will your different learners attempt the objective on their own? How will students apply the new knowledge and skills to solving a problem or meeting a challenge?	
	Students will work in groups to explore the concepts of reflection, refraction, and diffraction	
	REFLECTION: How will you have students summarize what they've learned and how they arrived at their current understanding? How will you reinforce the objective's importance and its link to past and future learning as well as new conceptual frameworks?	

	Students will do a final activity where they have to identify reflection, refraction, and diffraction on their own.	23) Colored pencils or pens
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EXTENSION: How will you incorporate ideas for further exploration?	
Using iPads, students will find pictures of everyday examples of reflection, refraction and diffraction. Students will distinguish between different types of waves such as breakers, deep water, shallow water, Tsunamis	
DIFFERENTIATION: How will you differentiate your instruction to reach the diversity of learners in your classroom (ELL STRATEGIES/IEP IMPLEMENTATION)?	
Lesson will be adjusted based on students' needs in class. Methods used can include the following: adjusting questions, anchoring activities, choice activities, centers, flexibility, grouping, independent study, tiered lessons.	

Name: _____

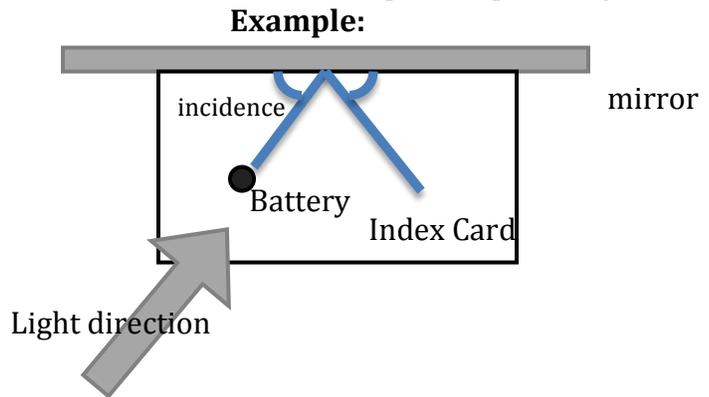
Wave: Reflection, Refraction, Diffraction

Waves interact with their environment in different ways. Each part of this lab will explore a way that waves interact with their environment.

Part One- REFLECTION:

- 1) Take an index card and place it next to the mirror (have a group member hold the mirror straight).
- 2) Turn on the lamp and shine it at an angle against the mirror.
- 3) Take the battery and stand it between the light source and mirror to create a shadow. Adjust the distance of between the light and mirror until you can clearly see the shadow going into the mirror and coming out of the mirror
- 4) Trace the shadow before it hits the mirror and again after it hits the mirror. (see example below)
- 5) Use the protractor to measure the angle of incidence (where it hits the mirror) and the angle of reflection (where it comes back out of the mirror). You will need to make the lines longer.
- 6) Record your data in the Data Table below.
- 7) Change the angle of the light source, turn the index card around and repeat steps 3-6 again
- 8) Staple the index card to this worksheet.

Position of Light	Angle of Incidence	Angle of Reflection
1		
2		



Questions:

- 1) How did the angle of incidence compare to the angle of reflection?
- 2) Give an example of an animal that uses wave reflection to help them.
- 3) Give an example of a technology that uses reflected waves to help humans.

Part Two- REFRACTION :

Waves travel at different speeds in materials of different densities. This causes them to change direction or “bend”, called **refraction**, when they hit those materials. The amount that the light **refracts** depends on its wavelength and the type of material it travels through.

- 1) Shine the light through the prism until you see a rainbow of colors on the other side, draw the prism and rainbow **in color** below.
- 2) Put the pencil in the beaker of water, look at it directly from the side, then draw what you see below.

PRISM	BEAKER
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Questions (For part two):

- 1) Why does a prism split the white light into a rainbow of colors?
- 2) Do electromagnetic waves of shorter or longer wavelengths refract more through the prism?
- 3) Would infrared waves refract more or less than the waves we see here?
- 4) Why does the pencil appear broken when viewed from the side of the beaker?
- 5) What is an example of how we use different materials to bend light in order to help humans?

Part Three- Diffraction:

Waves can bend around corners and objects and “spread out” through openings or away from their source. This is called **diffraction**. This is why we can hear sound from around a corner.

- 1) Turn on the light and place the cardboard with the slit close in front of it. (slit on the bottom)
- 2) Measure the width of the light beam, in millimeters, directly next to the cardboard and record it in the data table below.
- 3) Measure the width of the light beam, in millimeters, 5cm and 10cm away from the cardboard and record it in the data table below.

Data Table

Distance from slit in cardboard (centimeters)	Width (millimeters)
0cm	
5cm	
10cm	

Questions:

- 1) Why does the light beam become wider as you get further from the light source?
- 2) What is another example of waves spreading out from their source that we utilize every day?

Part Four:

- 1) Take a tray and fill it with about 2cm of water, let it sit on the table and don't bump it.
- 2) Use an eye dropper to drop a drop of water into the tray from ~30cm above it.
- 3) Identify each of the three ways waves interact with their environment (Reflection, Refraction, Diffraction) while watching the waves you created. Remember to think about the water waves and light waves.

Interaction Type	Explanation
Reflection	
Refraction	
Diffraction	

Name:

LAB: Measuring Dissolved Oxygen Saturation

Objective: How do temperature and salinity affect dissolved oxygen?

Background: Read and highlight the following article excerpt:

Unlike terrestrial environments, oxygen is typically a limiting factor in aquatic ecosystems. Dissolved oxygen (DO) concentrations are expressed as milligrams of oxygen per liter of water (mg/L). The amount of DO affects what types of aquatic life are present in a stream, because many species of fish and macroinvertebrates are sensitive to low DO levels. DO also regulates the availability of certain nutrients in the water. Many physical and biological factors affect the amount of dissolved oxygen in a stream. The physical factors that influence DO are temperature, altitude, salinity, and stream structure. Temperature inversely controls the solubility of oxygen in water; as temperature increases, oxygen is less soluble. In contrast, there is a direct relationship between atmospheric pressure and DO; as the pressure increases due to weather or elevation changes, oxygen solubility increases. Salinity also reduces the solubility of oxygen in water.

Hypothesis: If the temperature of water increases, then its dissolved oxygen levels will decrease. If the salinity of water increases, then its dissolved oxygen levels will decrease.

Experimental Procedure:

1. Use a thermometer to measure the temperature of your water sample. Record this in Table 1.
2. Use a refractometer to measure the salinity of your water sample. Record this in Table 1.
3. Record the temperature and salinity data from each group's sample in class in Table 1.
4. Use the nomograph of oxygen solubility below to determine the expected DO levels of each sample assuming the sample is 100% saturated. Record these values in Table 1.
5. Use the DO probe or test kit to measure the DO levels of your sample. Record this value in Table 1.
6. Record the measured DO data from each group's sample in class in Table 1.
7. Use the nomograph above to calculate the oxygen saturation of each sample. Record this in Table 1.

Data Analysis:

1. Table 1: Record your observations below.

Sample	Temperature (°C)	Salinity (ppt)	Expected DO at 100% Saturation (ppm)	Measured DO (ppm)	Oxygen Saturation (%)
1					
2					
3					
4					
5					
6					

2. Create a bar graph that compares temperature to dissolved oxygen levels in the graph provided below.
3. Create a bar graph that compares salinity to dissolved oxygen levels in the graph provided below.

Conclusion: Explain why your hypothesis was either supported or rejected by the data.

Discussion Questions:

1. How did temperature affect dissolved oxygen levels in this lab?
2. How did salinity affect dissolved oxygen in this lab?
3. Why are thermal pollution and potential global warming of concern to dissolved oxygen levels in the ocean?

An Exploration into the Determination of an Elkhorn Slough Species Using a Virtual Field Study/Gel Electrophoresis and Wet Lab

Background

The lesson is an inquiry-based lesson on an invasive species of snail. Students will learn about the Elkhorn slough and the animals that inhabit it. They will be given a bag of snails to observe. The problem they will arrive at is “why are there large snails and small snails?” Students will brainstorm (due to previous lessons, they should decide that they are different species of snail). Students will confirm species ID using virtual gel electrophoresis and BLAST searches. Once students see that both large and small snails are the same species, they will use lab investigation to find other reasons why their size is so variable. They will be introduced to the concepts of invasive species and parasitism during this lab investigation.

Technology Integration: Students will use electrophoresis apparatus, pipettes, compound microscopes, glass slides, slide covers, forceps, dissection probes, computers and computer data bases.

Goals(s):

- Goal 1 – Students will learn about invader and native species in the Elkhorn Slough and the distinction between those concepts.
- Goal 2 – Students will learn how restriction enzymes “cut” strands of DNA.
- Goal 3 – Students will learn how to “read” electrophoresis bands and distinguish between different species and complement species.
- Goal 4 – Students will learn how to use deductive reasoning and propose various hypotheses to explain the causes for size differences of snails that are the same species.

Learning Objective(s)

- Objective 1: Students will be able to use bioinformatics to confirm species ID
- Objective 2: Students will be able to use wet lab techniques in order to investigate Hypotheses
- Objective 3: Students will use inductive reasoning to solve a problem.

Materials/Resources

Computers

20 Rulers

10 snails (*Battilaria*) per group (various sizes) 1 Dissecting microscope per group

1 Compound light microscope per group Hammers (at least 1 per group)

Markers

Poster paper

Procedure

Introduction

1. We will be exploring virtually a field study project, an actual Gel Electrophoresis with DNA sequences and look at a species found in Elkhorn Slough.
2. A Brainstorming Activity will proceed with key terms/words explored to tap prior knowledge about those terms/words.
3. A Concept Map Activity using web sites will also allow students to use prior knowledge of computer skills and prior knowledge of Elkhorn Slough or similar environments.
4. Students will view a vodcast showing native and invasive species. Make connections between prior knowledge and experiences with what is presented. *Find out what students ideas are on this topic - uncover misconceptions!*
5. Use teaching charts, video clips, books, presentation software, instructional software, articles, tapes, overhead projector, handouts, models, etc. to accent instruction.
6. Create and describe the structure for group learning (if applicable), whole class discussion, and individual work (journal, worksheet).

Exploration

1. Webquest-biodiversity in the Elkhorn Slough
2. Discussion of quest
3. Snail morphological observation.
4. Snail vodcast (background and discussion of invasive species)
5. Bioinformatics- are the 2 types of snails the same species.
6. Brainstorming-what else could cause variation in size.
7. Wet lab- dissection and then do parasite lab.
8. Conclusion and reflection.

Application

1. Students learn about the differences between native and invasive species.
2. Students discover how scientists use biotechnology and bioinformatics to identify a species. Students will learn some internal organs of the snail.
3. Students will discover that size is controlled by parasitism.

This study can be extended by adding a fieldtrip to the collection area to learn proper collection techniques. Also by adding a population density portion.

Assessment

1. Small group debriefs given after each activity or lab to check students focus and understanding of each step of the lesson. Students given individual help by teacher and peers and handle all aspects of the virtual and wet labs with expected written and oral results.
2. A written/print or electronic assessment with questions and a final task using selective vocabulary in a poem, story, song or poster of the relevance of invader species, their release into Elkhorn Slough and support data of the extinction of the native species finalizes student understanding of the need for dual analysis of genetic data through gel electrophoresis and BLAST.