Course Title:	Content Area:	Grade Level:	Credit (if applicable)
Oceanography	Science	10-12	0.5

Course Description:

This course views oceanography as a science from four different perspectives: Biological, Chemical, Physical, and Geological. Through each perspective students will build an understanding of ocean zones, coastlines, and marine life; biogeochemical cycles; physical factors including-alinity, temperature; ocean floor, plate tectonics, boundaries, earthquakes, volcanoes, and trenches; waves, tides, thermohaline circulation, and weather; climate change; and human impact. This course embeds multiple hands-on and virtual lab experiences to enhance their knowledge and class experience. Students will be expected to research and share their findings through projects, models, written and/or oral reports and presentations.

Aligned Core Resources:	Connection to the *BPS Vision of the Graduate*
Digital Resources: Lawrence Hall of Science Simulations	CRITICAL THINKING AND PROBLEM SOLVING • Collect, assess and analyze relevant information • Reason effectively. • Use systems thinking. • Make sound judgments and decisions. • Identify, define and solve authentic problems and essential questions. • Reflect critically on learning experience, processes and solutions • Transfer knowledge to other situations COMMUNICATION • Articulates thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts. • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions. • Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade) • Communicate effectively in diverse environments.
Additional Course Information: ***Knowledge/Skill Dependent courses/prerequisites***	**Link to *Completed Equity Audit***
	Oceanography Equity Audit

Standard Matrix

Partial Connection to the Next Generation Science Standards

Next Generation Science Standards	Unit 1	Unit 2	Unit 3	Unit 4
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.				x
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into chemical energy.	x	x		
HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based	x	x		

molecules.				
HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.	x	x		
HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.	x	x		
HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about how factors affecting biodiversity and populations in ecosystems of different scales.	x	x		
HS-LS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.		x		
HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	x			
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	x			
HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.				x
MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.			x	
HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.				x
HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.		x	x	x
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.		x	x	
HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.		x	x	x
HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.		x	x	
HS-ESS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.		x		
HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.			x	

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).			x	

Unit Links

Biological Factors and Our Oceans
Chemical Factors and Our Oceans
Physical Factors and Our Oceans
Geology of Our Oceans

Unit Title:
Biological Factors and Our Oceans
Partial NGSS Connections: • HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. • HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. • HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. • HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy. • HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into chemical energy. • HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about how factors affecting biodiversity and populations in ecosystems of different scales.

Essential Question(s):	**Enduring Understanding(s):**
• How can physical, chemical, biological, and geological factors shape marine ecosystems? • What role do plants play in sustaining life in the oceans? • What role do animals play in sustaining life in the world's oceans? • How does the biodiversity of plants and animals shape specific marine ecosystems?	• Marine ecosystems are forged and maintained through the interaction of various factors including physical, chemical, biological and geological components. • Marine ecosystems biodiversity is dependent on global position and physical, chemical, biological and geological factors. • Plant life is essential to maintaining balance within a marine ecosystem. The presence of plant life supports organisms within other trophic levels and supports the chemical balance of the marine environment. • Each marine zone has unique biogeochemical factors that influence the zonal specific biodiversity. The species and populations found in one zone may not be the same as another zone. • Marine animals are dependent on the presence of marine plant life. • Marine animals exist in locations that meet their needs. Biogeochemical factors influence an organism's ability to survive in an ecosystem. • Marine ecosystems are dynamic in nature, changes to marine plant or animal populations may have a significant impact on the overall health of the ecosystem. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of the ecosystem's health.
Demonstration of Learning:	**Pacing for Unit**

	13 Blocks

Unit-specific Vocabulary:

Abyssal, abyssal zone, adaptation, algae, aphotic/midnight zone, Arctic ecosystem, autotrophic, bacteria, bathyal zone, bioluminescence, canopy, climate, climate change, colonial, coral bleaching, coral ecosystem, deep sea ecosystem, diatoms, dinoflagellates, diversity, diverse, drilling, dysphotic/twilight zone, epipelagic zone, euphotic/sunlit zone, extreme environment, fisheries, food chain, food web, habitats, hadal zone, invertebrates, kelp, kelp forest, latitude, longitude, mangrove, mesopelagic zone, multicellular, overfishing, pelagic zone, photophores, photosynthetic, phytoplankton, polar, pollution, polyps, protists, rocky shore, roots, sandy shore, sea floor, seagrass, seed, sonar, tide pools, tides, tropical, unicellular, vertebrates, zones.

Anticipated misconceptions:

- Misconception: Marine ecosystems are only shaped by physical factors like water temperature and currents.
  - Clarification: Marine ecosystems are influenced by a combination of physical, chemical, biological, and geological factors. Each of these factors plays a crucial role in shaping the environment and the organisms living within it.
- Misconception: The chemical composition of the ocean is the same everywhere.
  - Clarification: Chemical factors such as salinity, nutrient levels, and dissolved oxygen can vary significantly across different regions of the ocean. These variations impact marine life and the health of ecosystems, making each environment unique.
- Misconception: Only large animals like fish and whales are important in shaping marine ecosystems.
  - Clarification: All biological factors, including microorganisms, plants, and small invertebrates, play essential roles in marine ecosystems. They contribute to nutrient cycling, habitat formation, and energy flow through food webs.
- Misconception: Geological factors only refer to the physical structure of the ocean floor.
  - Clarification: Geological factors also include dynamic processes like volcanic activity, sedimentation, and plate tectonics, which influence the formation and evolution of marine ecosystems over time.
- Misconception: Human impact on marine animal biodiversity is minimal.
  - Clarification: Human activities such as overfishing, pollution, and climate change significantly impact marine animal biodiversity. These actions can lead to habitat loss, species decline, and disruptions in ecological balance.

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**
Comprehension: Highlight patterns, critical features, big ideas, and relationships	• Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**
I can argue the importance of plants and animals to specific marine ecosystems.	

An EL can . . . speak and write about grade-appropriate complex literary and informational texts and topics.

- Level 1: With prompting and support, I can use vocabulary to verbally explain the importance of plants and animals on marine ecosystems.
- Level 2: With prompting and support, I can illustrate and use vocabulary to explain the importance of plants and animals on marine ecosystems.
- Level 3: With guidance, I can model and explain the importance of plants and animals on marine ecosystems.
- Level 4 /5: I can model and use evidence to explain the importance of plants and animals on marine ecosystems.

Lesson Sequence	Learning Target	Success Criteria/Assessment/Resources
1 How can physical, chemical, biological, and geological factors shape marine ecosystems?	• I can question and explore the factors that shape a marine ecosystem.	• I can identify and describe how physical factors shape a specific marine ecosystem . • I can identify and describe how chemical factors shape specific marine ecosystems. • I can identify and describe how biological factors shape specific marine ecosystems. • I can identify and describe how geological factors shape marine ecosystems.
2 What role do plants play in sustaining life in the oceans?	• I can model and explain the role plants play in the world's oceans .	• I can identify major groups of plants found in the world's oceans by zones. • I can identify the biogeochemical factors that impact plant biodiversity. • I can plan an investigation to determine the importance of plants to marine systems. • I can connect the role of plants to specific marine ecosystems.
3 What role do animals play in sustaining life in the world's oceans?	• I can model and explain the role animals play in the world's oceans	• I can identify major groups of animals found in the world's oceans by zones • I can appraise the impact humans are having on animal biodiversity within the world's oceans. • I can connect the role of animals to specific marine ecosystems.
4 How does the biodiversity of plants and animals shape specific marine ecosystems?	• I can argue the importance of plants and animals to specific marine ecosystems through the critique of conservation plans.	• I can review and critique the validity of a conservation plan and propose improvements.. • I can defend a conservation plan to protect the biodiversity of plants and animals to protect marine ecosystems.

Unit Title:
Chemical Factors and Our Oceans
Relevant Standards: Bold indicates priority
Partial NGSS Connections: • HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into chemical energy. • HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. • HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy • HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. • HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems. • HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • HS-LS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • HS-ESS2-7.7Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Essential Question(s):	**Enduring Understanding(s):**
• What role does oxygen play within marine systems? • What role does temperature and salinity play within marine systems? • What role do biogeochemical cycles play within marine systems?	• Oxygen distribution in the ocean depends on both biological processes, like the respiration of organisms, and on physical processes such as current flow. Changes in either of these processes should therefore lead to changes in the oxygen distribution. Dissolved oxygen can be viewed as a kind of sensitive early warning system for global (climate) change in the ocean. Scientific studies show that this early warning system can detect the expected decrease in oxygen transport from the atmosphere into the ocean that is driven by global current and mixing processes, as well as possible changes in the marine biotic communities. • The ocean water is constantly churning underneath, bringing nutrients up to the top. The difference in density of cold water versus density of warmer water is responsible for ocean currents and upwelling. Warm seawater floats and cold , dense, seawater sinks, so ocean temperatures also vary across the surface and into the depths. Changes in the temperature and salinity can have a significant impact on marine ecosystems. • The term biogeochemical is derived from "bio" meaning biosphere, "geo" meaning the geological

	components and “chemical” meaning the elements that move through a cycle. The matter on Earth is conserved and present in the form of atoms. Since matter can neither be created nor destroyed, it is recycled in the earth’s system (including marine systems) in various forms. ● The major elements include: Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus, Sulphur. These elements are recycled through the biotic and abiotic components of the marine ecosystem. The atmosphere, hydrosphere and lithosphere are the abiotic components of the ecosystem.
Demonstration of Learning:	**Pacing for Unit**
	9 Blocks

Unit-specific Vocabulary:

Acidification, biogeochemical, brackish water, carbon cycle, climate change, concentration, cultural eutrophication, dead sea, density, deoxygenation, dissolved oxygen, downwelling, estuary, eutrophication, ground water, halocline, homeostasis, infiltration, nitrogen cycle, ocean acidification, ocean warming, phosphorus cycle, pressure, salinity, sewage pollution, thermohaline circulation, upwelling.

Anticipated misconceptions:

- Misconception: Salinity and temperature do not affect ocean circulation.
  - Clarification: Salinity and temperature differences drive thermohaline circulation, which is a major component of global ocean circulation. This circulation helps regulate climate by distributing heat and nutrients around the globe.
- Misconception: Ocean currents are only important for marine life.
  - Clarification: Ocean currents are crucial for global homeostasis. They help regulate climate, distribute nutrients and gasses, and support the life cycles of many marine organisms by transporting larvae and other life stages.
- Misconception: Human activities have a negligible impact on biogeochemical cycles.
  - Clarification: Human activities, such as pollution, deforestation, and fossil fuel combustion, significantly alter biogeochemical cycles. These changes can lead to negative impacts on marine ecosystems, such as ocean acidification, eutrophication, and disruptions in nutrient cycling.
- Misconception: Only carbon moves through marine systems in biogeochemical cycles.
  - Clarification: In addition to carbon, other essential elements like nitrogen and phosphorus also move through marine systems in biogeochemical cycles. These cycles are interconnected and support the health and productivity of marine ecosystems.
- Misconception: Salinity in the ocean is constant and not influenced by external factors.
  - Clarification: Salinity can vary due to factors such as freshwater input from rivers, evaporation rates, ice formation and melting, and human activities like desalination and pollution. These variations can impact marine life and ocean circulation.

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**
Engagement: Optimize relevance, value, and authenticity	● Design activities so that learning outcomes are authentic, communicate to real audiences, and reflect a purpose that is clear to the participants

	• Provide tasks that allow for active participation, exploration and experimentation
Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
I can support with evidence how biogeochemical cycles sustain the health of the world's oceans . An EL can . . . speak and write about grade-appropriate complex literary and informational texts and topics. • Level 1: With prompting and support, I can use vocabulary to verbally explain how biogeochemical cycles keep the oceans healthy. • Level 2: With prompting and support, I can illustrate and use vocabulary to explain how biogeochemical cycles keep the oceans healthy. • Level 3: With guidance, I can model and explain how biogeochemical cycles keep the oceans healthy. • Level 4 /5: I can model and use evidence to explain how biogeochemical cycles keep the oceans healthy.	

Lesson Sequence	**Learning Target**	**Success Criteria/Assessment/Resources**
1 What role does oxygen play within marine systems?	• I can compare and contrast oxygen levels within different marine systems and determine how it impacts these systems.	• I can explain how photosynthetic processes within a variety of organisms provide dissolved oxygen to marine systems. • I can design an investigation exploring factors that influence oxygen levels within marine systems. • I can analyze data to explain how varying levels of oxygen affect the health of an ecosystem.
2 What role does temperature and salinity play within marine systems?	• I can evaluate the importance of salinity and temperature within marine systems.	• I can analyze data to determine factors that increase or decrease salinity within ocean systems. • I can analyze data to determine factors that influence temperature within marine systems. • I can describe how salinity and temperature impact thermohaline circulation . • I can evaluate the importance of ocean currents to global homeostasis.
3 What role do biogeochemical cycles play within marine systems?	• I can support with evidence how biogeochemical cycles sustain the health of the world's oceans .	• I can model how carbon moves through marine systems and explain how it supports homeostasis. • I can model and describe how phosphorus moves through marine systems and how it supports homeostasis. • I can model and describe how nitrogen moves through marine systems and how it supports homeostasis. • I can make a claim supported with evidence regarding how human activity impacts (+/-) biogeochemical cycles.

Unit Title:

Physical Factors and Our Oceans

Relevant Standards: Bold indicates priority

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
- HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

Essential Question(s):	**Enduring Understanding(s):**
• How do different types of ocean waves impact marine and terrestrial systems? • What are the causes and effects of tides? • How does temperature impact ocean dynamics?	• Waves also work in combination with tides and currents to carry nutrients to marine animals including those that live along the shorelines. By pushing water onto the shore, waves make it possible for intertidal animals to live in areas of beaches and shorelines that would otherwise be too dry to sustain them. • High and low tides are caused by the Moon. The Moon's gravitational pull generates something called the tidal force. The tidal force causes Earth—and its water—to bulge out on the side closest to the Moon and the side farthest from the Moon. These bulges of water are high tides. • The ocean is the largest solar energy collector on Earth. Not only does water cover more than 70 percent of our planet's surface, it can also absorb large amounts of heat without a large increase in temperature. This tremendous ability to store and release heat over long periods of time gives the ocean a central role in stabilizing Earth's climate system.
Demonstration of Learning:	**Pacing for Unit**
	7 Blocks
Unit-specific Vocabulary:	

Weather, climate, currents, erosion, gravitational pull, high tide, intertidal zone, low tide, lunar, neap tide, rip, solar, submarine earthquakes, submarine volcanoes, temperature, thermodynamic, thermoclines, thermohaline circulation, tidal force, tidal waves, tide pool, wind waves, tsunami.

Anticipated misconceptions:

- Misconception: All ocean waves have the same impact on marine and terrestrial systems.
  - Clarification: Different types of ocean waves vary in their energy, frequency, and amplitude, leading to diverse impacts on marine and terrestrial systems. Understanding these differences is crucial for comprehending their effects on coastal erosion, sediment transport, and ecosystem dynamics.
- Misconception: Tides and waves are the same phenomenon.
  - Clarification: Tides result from the gravitational pull of celestial bodies like the moon and sun, causing cyclic changes in sea level, while waves are disturbances propagated through the ocean surface primarily by wind, seismic activity, or gravitational forces. Recognizing this distinction helps in understanding their respective impacts on coastal areas and ecosystems.
- Misconception: Tides and waves have no influence on terrestrial systems.
  - Clarification: Tides and waves indirectly affect terrestrial systems through processes such as erosion, sediment deposition, and flooding. Their impacts extend beyond the coastlines, shaping landforms, influencing habitat availability, and affecting human activities and infrastructure in coastal regions.
- Misconception: Increasing oceanic temperature only affects marine systems.
  - Clarification: Rising oceanic temperatures have widespread impacts on both marine and terrestrial systems. These include coral bleaching, shifts in marine biodiversity, rising sea levels leading to coastal inundation, and alterations in weather patterns and climatic conditions, affecting terrestrial ecosystems and human populations.
- Misconception: Oceanic zones and temperature ranges only impact marine ecosystems.
  - Clarification: Understanding oceanic zones and their temperature ranges is essential for comprehending their broader impacts on weather patterns, climate regulation, and terrestrial ecosystems. Ocean temperature influences atmospheric circulation, precipitation patterns, and climatic conditions, shaping terrestrial ecosystems and human livelihoods worldwide.

Differentiation through *Universal Design for Learning*

UDL Indicator	**Teacher Actions:**
Language and Symbols: Clarify vocabulary and symbols	• Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge • Provide graphic symbols with alternative text descriptions • Highlight how complex terms, expressions, or equations are composed of simpler words or symbols • Embed support for vocabulary and symbols within the text (e.g., hyperlinks or footnotes to definitions, explanations, illustrations, previous coverage, translations) • Embed support for unfamiliar references within the text (e.g., domain specific notation, lesser known properties and theorems, idioms, academic language, figurative language, mathematical language, jargon, archaic language, colloquialism, and dialect)

Supporting Multilingual/English Learners

Related *CELP standards:*	**Learning Targets:**

I can develop a model to explain the influence of physical factors on specific marine ecosystems.
An EL can . . . speak and write about grade-appropriate complex literary and informational texts and topics.

- Level 1: With prompting and support, I can use vocabulary to verbally explain how temperature and salinity impact marine ecosystems.
- Level 2: With prompting and support, I can illustrate and use vocabulary to explain how temperature and salinity impact marine ecosystems.
- Level 3: With guidance, I can model and explain how temperature and salinity impact marine ecosystems.
- Level 4 /5: I can model and use evidence to explain how temperature and salinity impact marine ecosystems.

Lesson Sequence	**Learning Target**	**Success Criteria/Assessment/Resources**
1 How do different types of ocean waves impact marine and terrestrial systems?	• I can model and explain how different types of ocean waves impact marine and terrestrial systems.	• I can identify factors that influence wave activity within oceans. • I can model and explain how different types of waves are formed. • I can use a computer simulation to compare and contrast the impact different waves have on terrestrial and marine features. Resources: Lawrence Hall of Science Simulations
2 What are the causes and effects of tides?	• I can explain why tides are cyclic and predict tidal conditions for a given area.	• I can identify and explain the differences between tides and waves. • I can model and explain how specific factors influence tides. • I can research and describe the effects of tides on coastal systems.
3 How does temperature impact ocean dynamics?	• I can use data as evidence to argue the impact of increasing oceanic temperature on both marine and terrestrial systems. **Unit Assessment:** I can develop a model to illustrate the influence of physical factors on specific marine ecosystems.	• I can identify oceanic zones according to their temperature range. • I can model and explain the characteristics of each ocean zone. • I can use patterns derived from data to connect ocean temperature to weather conditions. • I can construct an explanation to define the role of the oceans in climatic conditions. • I can interpret data related to warming oceans and predict the impact to both marine and terrestrial systems.

Unit Title:

Geology of Our Oceans

Relevant Standards: Bold indicates priority

- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
- HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.
- HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
- HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
- MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases
- HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.
- HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into chemical energy.
- HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about how factors affecting biodiversity and populations in ecosystems of different scales.

Essential Question(s):	**Enduring Understanding(s):**
• How do tectonic forces influence oceans? • How do geologic processes influence biodiversity of marine organisms? • How does sedimentation impact marine systems? • How do biological, chemical, physical, and geologic factors influence specific marine ecosystems?	• When tectonic plates slide, sink and shift the Earth's continents to form large landmasses, or supercontinents, ocean basins open and close in tandem. As these basins change shape, they can strike forms that amplify and intensify their tides. • A significant component of the trajectory of marine biodiversity over the past 443 million years is attributed to the assembly and disassembly of the supercontinent Pangaea through plate tectonics. • A multitude of processes occur in the ocean from the movement of huge underwater plates to the conditions that affect the everyday life of the amazing creatures that can exist in some of the ocean's most extreme environments. • The environmental impacts of sedimentation include the following: loss of important or sensitive aquatic habitat, decrease in fishery resources, loss of recreation attributes, loss of coral reef communities, human health concerns, changes in fish migration, increases in erosion, loss of wetlands, nutrient

	balance changes, circulation changes, increases in turbidity , loss of submerged vegetation, and coastline alteration. ● Sediments are absolutely necessary for aquatic plant and animal life. Managed properly, sediments are a resource; improper sediment management results in the destruction of aquatic habitat that would have otherwise depended on their presence. ● Marine ecosystems are forged and maintained through the interaction of various factors including physical, chemical, biological and geological components. ● Marine ecosystems biodiversity is dependent on depending on global position and physical, chemical, biological and geological factors.
Demonstration of Learning:	**Pacing for Unit**
	10 Blocks

Unit-specific Vocabulary:

Adaptation, Adaptations, Abyssal, Abyssal plain, Abyssal zone, Alluvial deposits, Aphotic/midnight zone, Arctic ecosystem, Barrier islands, Bathyal zone, Bioluminescence, Canopy, Climate, Cold seep, Cold seep organisms, Colonial, Convergent boundaries, Coral ecosystem, Deepsea Challenger, Diverse, Diversity, Divergent boundaries, Dysphotic/twilight zone, Ecosystems, Epipelagic zone, Euphotic/sunlit zone, Extreme environment, Fisheries, Food chain, Food web, Hadal zone, Hydrothermal vent organisms, Hydrothermal vents, Invertebrates, Latitude, Longitude, Marine geology, Mariana's Trench, Mesopelagic zone, Mid-Atlantic Ridge, Nutrient deposits, Ocean basins, Ocean hotspots, Oceanic trenches, Pelagic zone, Plate tectonics, Polar, Polyps, Ring of Fire, Sea floor, Submarine earthquake, Submarine volcanoes, The Lost City, Tides, Tide pools, Transform boundaries, Tropical.

Anticipated misconceptions:

- Misconception: Plate tectonics only affect the geography of landmasses and have minimal impact on marine ecosystems.
  - Clarification: Plate tectonics influence the formation of oceanic features such as trenches, ridges, and volcanic islands, which in turn affect ocean circulation patterns, habitat availability, and biodiversity. Understanding these connections is crucial for comprehending the broader impacts of plate tectonics on marine and terrestrial systems.
- Misconception: Geologic processes do not play a significant role in biodiversity.
  - Clarification: Geologic processes, such as volcanic activity, tectonic movements, and sedimentation, directly and indirectly influence biodiversity by creating and altering habitats, shaping coastlines, and providing nutrient sources. Recognizing these connections helps in understanding the dynamic interplay between geology and biodiversity in marine and terrestrial ecosystems.
- Misconception: Sedimentation only has negative effects on marine systems.
  - Clarification: While sedimentation can negatively impact marine ecosystems by smothering habitats and reducing water clarity, it also plays essential roles in ecosystem dynamics. Sediment deposition can create new habitats, replenish nutrient levels, and support diverse communities of organisms, highlighting the complex and multifaceted nature of its effects.
- Misconception: Marine ecosystems are solely shaped by biological factors, with geologic processes playing a minor role.
  - Clarification: Geologic factors interact with biological, chemical, and physical processes to shape marine ecosystems. These interactions influence habitat formation, nutrient cycling, and species distribution, highlighting the importance of considering geology alongside other factors in ecosystem analysis and management.

- Misconception: Marine ecosystems are independent entities with minimal interdependence.
  - Clarification: Marine ecosystems are interconnected and interdependent systems influenced by biological, chemical, physical, and geologic factors. Changes in one ecosystem can have cascading effects on others, highlighting the need for holistic approaches to ecosystem management and conservation that consider the complex web of interactions between marine environments.

Differentiation through *Universal Design for Learning*	
UDL Indicator	**Teacher Actions:**
Sustaining Effort & Persistence: Increase mastery-oriented feedback	• Provide feedback that encourages perseverance, focuses on development of efficacy and self-awareness, and encourages the use of specific supports and strategies in the face of challenge • Provide feedback that emphasizes effort, improvement, and achieving a standard rather than on relative performance • Provide feedback that is frequent, timely, and specific • Provide feedback that is substantive and informative rather than comparative or competitive • Provide feedback that models how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success

Supporting Multilingual/English Learners	
Related *CELP standards:*	**Learning Targets:**
I can combine biological, chemical, physical, and geological factors to comprehensively model or explain how a specific marine environment maintains homeostasis and stability. An EL can . . . speak and write about grade-appropriate complex literary and informational texts and topics. • Level 1: With prompting and support, I can use vocabulary to verbally explain how a specific marine environment maintains stability. • Level 2: With prompting and support, I can illustrate and use vocabulary to explain how biological, chemical, physical, and geological factors help a marine ecosystem maintain homeostasis and stability • Level 3: With guidance, I can model and explain how biological, chemical, physical, and geological factors help a marine ecosystem maintain homeostasis and stability. • Level 4 /5: I can model and use evidence to explain how biological, chemical, physical, and geological factors help a marine ecosystem maintain homeostasis and stability.	

Lesson Sequence	**Learning Target**	**Success Criteria/Assessment/Resources**
1 How do tectonic forces influence oceans?	• I can evaluate the impacts of oceanic plate tectonics to marine and terrestrial systems.	• I can relate the movement of convergent plates to oceanic features and events. • I can relate the movement of divergent plates to oceanic features and events. • I can relate the movement of transform boundaries to oceanic features and events.
2 How do geologic processes	• I can explain how geologic processes influence biodiversity.	• I can use patterns to deduce how structural and physiological adaptations within organisms support biodiversity in harsh environments..

influence biodiversity of marine organisms?		• I can plan and conduct a research activity that connects geologic factors to biodiversity.
3 How does sedimentation impact marine systems?	• I can construct an explanation anchored in evidence to how sedimentation occurs and how it affects marine systems both positively and negatively.	• I can analyze and use patterns in data to connect the influences of geologic factors to specific marine ecosystems. • I can communicate scientific information related to my explanation, clearly and constructively to peers.
4 How do biological, chemical, physical, and geologic factors influence specific marine ecosystems?	• I can combine biological, chemical, physical, and geological factors to comprehensively model or explain how a specific marine environment maintains homeostasis and stability.	• I can model and explain how geologic processes change marine systems physically, chemically, and biologically over time. • I can effectively communicate my findings to my peers through a platform of my choice (model, electronic presentation, etc.). • I can validate the claim that all marine ecosystems are interdependent on each other through biological, chemical, physical, and geologic factors.