CORAL REEFS

Objective:

1. Students will evaluate and explain the impact of ultraviolet rays on coral reefs.
2. Students will analyze and discuss the importance of clean ocean water on organisms living in reefs.
3. Students will understand the changes and risks related to reef environments.
4. Students will demonstrate an understanding of relationships among reef species and their survival.
5. Students will analyze and hypothesize the future of coral reefs.

Performance Objectives:

Grade 6: Strand 3: Concept 1 PO 1; Strand 4: Concept 1 PO 1; Concept 3 PO 1 and 2
Grade 7: Strand 3: Concept 1 PO 1; Strand 4: Concept 3 PO 2; PO 4 – 6
Grade 8: Strand 3: Concept 1; Strand 4: Concept 3
NGSS: MS-LS2; MS-ESS3-5

Grade 6 – 8

Key Vocabulary:

- **Atoll**
- **Polyp**
- **Calcareous**
- **Biodiversity**
- **Photosynthesis**

Related Literature:

Great Barrier Reef
Cynthia K. Henzel

Coral Reefs: In Danger
Samantha Brooke

Coral Reefs Matter
Julie Murphy

Coral
Lynn George

Background Information:

The ocean floor is as filled with living **organisms** as it dominates in size and depth on the Earth. Many regions of the ocean remain a mystery, and new discoveries are being made every day. It is difficult to comprehend the number of living species in the ocean and how each is a part of the cycle of life on Earth. Oceanographers know that the ocean ecosystem houses over 100 million species including all varieties of sharks, rays, sea snakes, jellyfish, and coral. All of these species and countless others live in their own unique habitats, balancing predator and prey instincts, and surviving in the ocean community.
One of the most unique, life-sustaining ecosystems in the ocean is coral reefs. Coral reefs are animals, not plants, and are essential to other organisms that live

among them. The largest and most famous of the coral reefs is the Great Barrier Reef. With over 2,900 separate reefs, the alignment can be seen from space as it stretches 1,400 miles along the coast of Queensland, Australia. Coral reefs are one the most biodiverse habitats on earth. The reef is located approximately 10 to 100 miles offshore depending on the contour of the ocean floor. The reef was formed over millions of years of **calcareous** (made up of calcium substance) remains from tiny creatures known as coral **polyps**. The surface water temperature of 70 to 100 degrees allows the coral to continue to flourish, supporting all of the living organisms that are dependent on the reef for food and protection. Each section of reef consists of numerous living organisms and can be described as having multitudes of habitats. In many locations of the reef species such as anemones, sponges, worms, gastropods, lobsters, sea stars, and crayfish can be observed living in communal relationships with the coral.

The Great Barrier Reef has an extraordinary and complex **biodiversity**. Every individual species plays a part in the interdependent relationship that exists between all of them. Six species of sea turtles, seventeen species of sea snakes, over 1,500 fish species, 215 species of birds, and over 400 species of hard coral co-exist and support life on the reef.

This photo of the Great Barrier Reef was taken from space. It is clear to see how the reef begins offshore and follows the contour of the land. Changes in color denote the area of the reef and the small 'islands' that connect the great expanse known as the Great Barrier Reef.
The world's largest coral ecosystem includes over 2,900 separate coral reefs which make up the rich and diverse Great Barrier Reef, an ocean community of living organisms.
(NOAA Photo)

Different types of reefs are located in various waters of the world. The three main types of reefs are **fringing**, **atolls**, and **barrier** reefs. The Great Barrier Reef is the largest of all and is a barrier type. The term 'barrier' is used due to the extended distance of the reef offshore, which allows lagoons to form between the shoreline and the reef. Often the water between shore and reef is very deep. Marine animals living in the coral are closer to the surface. In addition, the lagoon areas can house larger species of marine life who live and hunt in the deeper water. The crystal clear water is a necessity for the coral reef to grow and thrive.

Fringing reefs are those that extend toward the ocean directly from the shore. Fringing reefs are the most common form of reef. For example, the Red Sea Reef in the Indian Ocean is considered a fringing reef which extends along 1240 miles of shoreline. This hardy reef has unique types of coral that appear more tolerant to climate and temperature changes. Scientists have determined that approximately 10% of the coral fish found in the Red Sea area are not found anywhere else.

Notice how the fringing reef begins at the shoreline in this picture of a reef in the Red Sea. The Red Sea Reef is home to a variety of species that prefer the coastal waters and plentiful food.

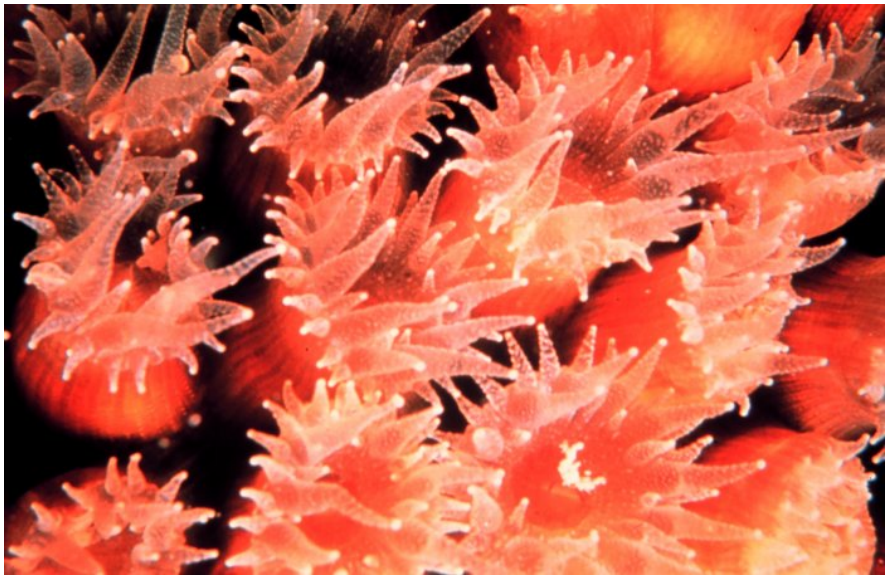
Reefs formed as a result of a volcanic island sinking back into the sea are called **atolls**. Atolls generally appear oblong or round with a lagoon in the center. Atolls are coral formations that house various habitats for marine life much the same as other coral reefs. Atolls like the one at Lighthouse Reef in Belize are also popular scuba diving spots and welcome visitors with their colorful ocean species.

Lighthouse Reef, Belize (NOAA Photo)

Rays are among the marine species that swim around the atoll reefs. Along with a variety of colorful large and small fish species, sea turtles, sharks, and dolphins visit the reef feeding grounds on a regular basis. Coral and sea sponges are among the inhabitants that form this unique ecosystem.

Each type of reef is made of a collective system of living organisms that includes various species of coral. Coral, closely related to jellyfish and anemones, flourish by creating colonies consisting of coral polyps. Each polyp houses algae that use **photosynthesis** to maintain health and continual growth. The collective colony of polyps creates what is called a coral head. The coral head is home for thousands of individual polyps, which extend their tentacles to attract food.

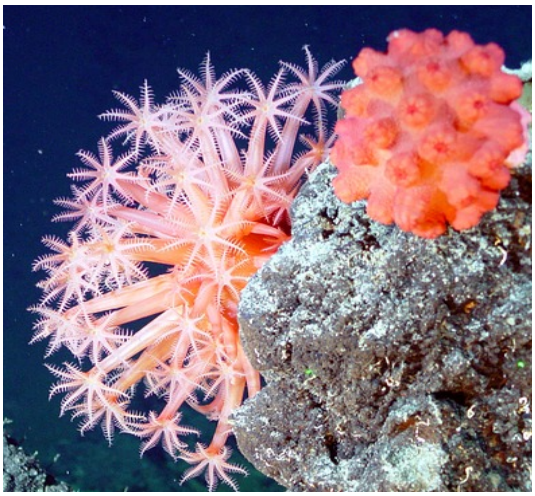
The star coral shows each individual tentacle extending out into the water. As the tentacles wave about, fish are likely to swim close; then they are stung and drawn in for eating.
(NOAA Photo)



Coral can be divided into two groups, hard coral, and soft coral. Hard coral is the building foundation of the reef. Over time, colonies of coral polyps produce limestone skeletons that extend outward and upward into various shapes and sizes. Healthy coral is generally colorful and teeming with polyps waving their tentacles in the water.
Soft coral does not have a solid skeleton and is flexible in the water. Sometimes mistaken as plants, soft coral is supported by spicules, which look like spikes. Soft coral has tentacles with a feather-like appearance. Soft coral makes a comfortable home for many marine species that live among the branches often camouflaging themselves by taking on the color of the coral. Tiny shrimp, snails, and fish are among the species living in soft coral.

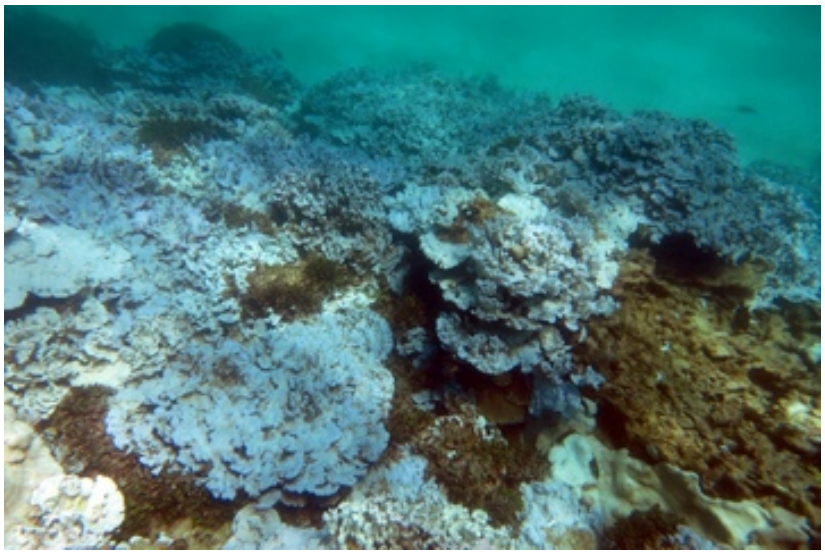
Hard Coral

Soft Coral



Protecting the world's coral reefs is an ongoing challenge. Coral reefs are often in danger from predators of the deep. For example, the crown of thorns starfish has been found to be a ravenous eater of coral. Oceanographers have detected a large increase in the population of crown of thorn starfish since 1970 and significant damage done to certain coral reef areas since that time. These rapidly moving starfish make their way over the coral smothering it and injecting venom through their stomach. Soon after, the starfish eat the polyps leaving only the vacant skeleton behind. Since the crown of thorns can produce hundreds of thousands of offspring at one time, 'outbreaks' of these starfish can consume significant colonies of coral in as little as a week. Controlling the crown of thorn population takes place as healthy reefs attract marine animals that feed on the starfish.
Clean ocean water is one key to maintaining a healthy coral reef and marine life ecosystem. Damaging oil spills, pollutants, chemicals, and litter in the water continues to be part of the concern over protecting the oceans. Over fishing and destructive fishing are concerns when the natural balance of ocean regions is disrupted. Coral diseases have risen in the past ten years and spread around the world damaging areas of reefs. An abundance of harmful fungi, bacteria, and viruses are to blame for the loss of numerous reef corals. Climate changes may be contributing to the spread of diseases as temperature changes have enormous impacts on coral reefs. Temperature changes have influenced the changes in tides along the reefs. Coral reefs thrive in water held at constant temperatures. The slightest changes that allow more exposure to ultraviolet rays from the sun can cause great damage to coral reefs. Coral bleaching takes place when the coral is exposed to higher than normal water temperatures and ultraviolet rays, for extended periods of time. The extra light causes the coral to become stressed and causes it to release is symbiotic zooxanthellae. With the zooxanthellae gone the coral can no longer photosynthesize. The two most significant coral bleaching

events in the Great Barrier Reef took place in 1998 and 2002. Currently, a third coral bleaching event is feared by scientists observing climate changes around the world.



The devastating impact of coral bleaching in one area of Hawaii's reef is recognized by the whitened coral. The once healthy coral is reduced to skeletal remains following the event of coral bleaching.
(NOAA Photo)

Life on Earth is constantly changing, but what remains the same is that world-wide attention must be given to protecting natural resources, supporting ecosystems on land and in the sea, keeping the water clean and safe, and understanding that community relationships are key to a healthy planet.

Additional Resources:
Coral Bleaching: https://www.youtube.com/watch?v=fA6mpexcyN4
Coral Time-lapse: https://www.youtube.com/watch?v=fbYA6uZFJ-w
Coral Eating: https://www.youtube.com/watch?v=tZuxZdG6TfM
Coral Bleaching Great Barrier Reef: https://www.youtube.com/watch?v=I_dC2swK9AY

Sources: Great Barrier Reef Marine Park Authority; World Wildlife Federation; Britannica; National Oceanic and Atmospheric Administration.

 **Indicates 'take along' activity.**

Procedures and Activities:

1. State the learning objectives. Review previous instruction as it relates to the topic and objectives.
2. Review vocabulary.
3. Read related literature. Engage students in open-ended questioning and discussion of the topic. Evaluated the level of prior knowledge and experience students may have regarding the topic.
4. Discuss coral reefs around the world and refer students to the use of technology to investigate areas of oceans and seas where coral reefs are located. Demonstrate how to relate distances from one location to another. Compare the similarities and differences in longitude and latitude, climate, and bodies of water.
5. Discuss the concept of global communities, ecosystems, and habitats. Ask students to give examples of each in the human, animal, and marine worlds.
6. In the marine environment, discuss the predator and prey cycle. Relate this to both large and small creatures including coral. Clarify that coral is an animal and discuss how coral is formed and multiplies.
7. Discuss changes in climate as it relates to coral reefs. Ask students to give examples of how higher or lower temperatures would affect coral reefs.
8. Discuss invasive species, such as the crown of thorns starfish, and the impact on coral reefs. In addition, discuss predator/prey relationships, how some species have found a niche in the environment, and the balance of the ecosystem.

 **Activity:** "Coral Reef Adaptations" reinforces a species ability to adapt to a unique habitat. Students can choose adaptations that would best fit in a coral reef environment and explain their reasoning.

Activity: Students use the "Coral Reef Data Sheet" to gain knowledge of the importance of coral reefs, and to organize data by charting or graphing. In addition, students analyze the data and make predictions for the future of coral reefs. Furthermore, students can predict economic changes in the next 10 years as it relates to protecting coral reefs.

Activity: "Types of Coral Reefs" activity allows students to share their knowledge by identifying the characteristics of the three main types of coral reefs.

Activity: The coral bleaching chart is informational and provides background for students to use analysis, engineer a plan to help with the problem, and predict results.

 **Activity:** "OdySea Aquarium Ethogram" is an activity to do at the aquarium. Students observe a coral reef habitat and chose one fish or other animal to observe for two minutes. From the observational data, make an inference about how the animal spends its day.

Activity: "Sea Turtle Diet". Through brief descriptions and pictures, students match 4 species of sea turtle with their diet.

Activity: The coral reef quiz is a culminating activity that checks for understanding.

Activity: Students use their creativity in making a coral reef diorama.

Activity: Students create a poster with a message about protecting coral reefs and their relevance to life on Earth.

Reflections and Assessments:

Students are assessed on varied levels depending on the activity. Participation, grade standards, and percentages may be applied to each activity. Activities are designed for flexibility and use pre or post fieldtrips.

Most activities meet the STEM education guidelines involving problem solving, investigation, gathering data, analysis, using technology, application of math, integration of interdisciplinary instruction and inquiry.

Coral Reef Adaptations

To live in a coral reef, animals must have special adaptations to survive. Most animals that live in coral reefs are colorful to help camouflage and are able to maneuver between the reefs easily. Choose the adaptations that would best fit in a coral reef environment.

Camouflage:

Countershading

Warning

Colorful

Disruptive

Cryptic

Body Shape:

Depressed

Compressed

Fusiform

Elongate

Irregular

Explain why you chose the adaptations to live in a coral reef habitat:

Coral Reef Data Sheet

Use the data to create a graph or chart that demonstrates life on a coral reef. In addition, analyze data and use technology to predict the changes in coral reefs and the future status of reef survival.

1625 species of fish

1400 coral species

3000 mollusks (shell) species

133 species of sharks and rays

6 species of sea turtles

14 species of sea snakes

30 species of marine mammals (whales and dolphins)

World's largest population of dugongs

22 seabird species

40 anemone species

100 jellyfish species

Coral reefs are threatened by a number of forces. For example:

* Over fishing and destructive fishing methods – Taking too many fish in one location and/or use of chemicals and explosives to render fish inactive for easy catching.

* Pollution – Oil, litter, pollutants flushed into the ocean or in beach area runoffs.

* Coral diseases – In the past 10 years coral diseases appear to be on the rise around the planet: fungi, bacteria, and viruses.

* Rising sea temperatures – Current studies show that the average temperature of the oceans has increased from studies done in 1961.

* Exposure to ultraviolet light – Many coral reef areas have experienced low tides for extended periods of time allowing the ultraviolet rays to ‘bleach’ or kill the coral polyps leaving only a skeletal shell of the once thriving coral.

* Acid ocean water – Recent studies have shown that the pH balance in the ocean waters has changed causing the water to absorb more carbon dioxide

from the atmosphere. This causes the water to become more acid, which is harmful to many aquatic species.

* Crown of Thorn Starfish – These invasive starfish are voracious coral predators. A significant increase in the population of Crown of Thorn Starfish has been detrimental to many coral areas.

Coral reefs are beneficial in many ways to life on the planet. The chart demonstrates four areas in which coral reefs and humans have formed a relationship.

NOAA Chart

Coral reefs are primarily located in the following bodies of water:

* Pacific Ocean

* Indian Ocean

* Caribbean Sea

* Red Sea

* Persian Gulf

Sources: NOAA, Great Barrier Reef Authority.

Types of Coral Reefs

Match the type of reef to the correct description.

Barrier Reef

The most common form of reef and extends toward the ocean directly from the shore.

Named due to the extended distance of the reef offshore, which allows lagoons to form between the shoreline and reef.

Atoll

Fringing Reef

Generally appearing oblong or round with a lagoon in the center, these are formed as a result of a volcanic island sinking back into the sea.

Types of Coral Reefs- KEY

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Coral Bleaching

Corals have a symbiotic relationship with microscopic algae called *zooxanthellae* that live in their tissues. These algae are the coral's primary food source and give them their color.

When the symbiotic relationship becomes stressed due to increased ocean temperatures or pollution, the algae leave the coral's tissue.

Without the algae, the coral loses its major source of food, turns white or very pale, and it's more susceptible to disease.

What causes coral bleaching?

1. Change in ocean temperature: Increased ocean temperature caused by climate change is the leading cause of coral bleaching.
2. Runoff and pollution: Storm generated precipitation can rapidly dilute ocean water and runoff can carry pollution- these can bleach near-shore corals.
3. Overexposure to sunlight: When temperatures are high solar radiance contributes to bleaching in shallow-water corals.
4. Extreme low tides: Exposure to the air during extreme low tides can cause bleaching in shallow corals.

Coral Bleaching

Increased ocean temperature caused by climate change is the leading cause of coral bleaching. How will you do your part in reducing your carbon footprint and becoming more environmentally friendly?

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OdySea Aquarium Ethogram

Practice what it is like to be a behavioral biologist and study one animal at OdySea Aquarium for two minutes.

An Ethogram is a way we can record the behavior of an animal over time in order to make inferences, or assumptions, about how an animal generally spends its time.

Every 15 seconds, mark what behavior the animal is exhibiting.

Species: _____

OdySea Aquarium Ethogram					
	Resting	Moving	Hiding	Eating	Other
0:15					
0:30					
0:45					
1:00					
1:15					
1:30					
1:45					
2:00					

Inference about animal's behavior:

_____

_____

_____

_____

Sea Turtle Diets

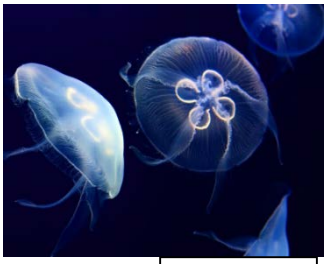
There are seven different species of sea turtles that are adapted to have various diets. Match the sea turtle species and their special adaptations to their diet.

Green Sea turtles have a serrated jaw to use as scissors

Hawksbill Sea Turtles have a sharp beak to tear their food.

Loggerhead sea turtles have strong jaws for crushing.

Leatherback sea turtles have spines in their throat to catch their food.



Jellyfish

Sea Grass

Sea Sponge

Crab

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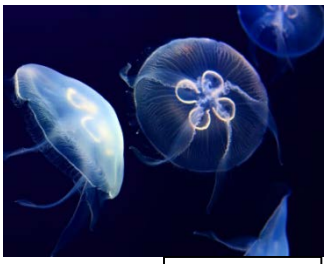

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Coral Reef Quiz

Complete the coral reef quiz.

1. What is the largest reef in the world?
   a. Fence Reef
   b. Sea Reef
   c. Great Barrier Reef
   d. Florida Big Reef

2. Coral reefs cannot live in temperatures less than ____ degrees?
   a. 40
   b. 65
   c. 70
   d. 90

3. Coral reefs are mainly made of what?
   a. Polyps
   b. Algae
   c. Marine life
   d. Sand

4. What do coral reefs use to kill their prey?
   a. Their mouth
   b. Poison they shoot out from their stomach
   c. Their tentacles
   d. Their teeth under their chin

5. What is one of the major threats that can harm coral reefs?
   a. Sharks
   b. Algae
   c. Light
   d. Water pollution

6. What does it mean when a coral reef is brightly colored?
   a. It is overheated
   b. It is alive and healthy
   c. It is trying to attract other marine life
   d. It is exposed to perfect amounts of sun

7. In what societies do polyps live?
   a. They live by themselves
   b. They live in colonies
   c. They live in marine life that live in coral
   d. They live in the salt in the water

8. Of which type of rock is a coral reef made?
   a. Limestone
   b. Flint
   c. Quartz
   d. Coral rock

9. What are the main structures of a polyp?
   a. Tentacles, nose, fingers
   b. Toes, mouth, chin
   c. Guts, tentacles, mouth
   d. Guts, tentacles, skeleton

10. Where is the coral's skeleton located?
   a. Around the top of the coral's body
   b. At the bottom of the coral tentacles
   c. All over the coral's body
   d. Around the bottom of the coral's body

Coral Reef Quiz- KEY

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Coral Reef Diorama

Materials:

Shoe box, colored tissue paper, pipe cleaners, scissors, glue, sandpaper, paint, and tropical fish cutouts, and small rocks, and construction paper. Optional: O cereal, spiral pasta, plastic fish, and sea plants from hobby store.

Cover the entire shoe box with tissue paper and glue to hold, or paint the box. Turn the box on its side and line the inside bottom with sand paper to indicate a sandy ocean floor. Begin to arrange the marine animals and plants to create a coral reef. Add a few small rocks to the ocean floor.

Suggestions: sponges can be cut into squares or circles and glued in the diorama, small Styrofoam balls can be halved and tooth picks added to represent sea urchins, twisted pasta glued on half of the foam ball and painted can become brain coral. Gluing O cereal on rocks or foam balls looks like coral. Rocks can become part of the coral with tissue paper streamers as coral polyps, clay can be molded into shapes, etc.

Ask students to be creative and imagine the marine life on their coral reef.