

Coral Reefs

Eco-Meet Study Guide

Helpful Hints

This study guide will focus on Coral Reefs around the world. The Eco-Meet test may consist of multiple choice, true/false, fill in the blank, matching, identification, label a diagram, or short answer. Pay close attention to words in bold, diagrams, charts, and identification. Questions come directly from the study guide. Students do not need to memorize the scientific name, it is listed as reference only.

What is a Coral Reef?

Coral reefs are one of the most diverse **ecosystems** in the world; a community of interacting organisms and their physical environment. It is estimated that about one-third of all marine fish species and one-fourth of all other marine species live in coral reefs at some point in their lives. That is amazing considering coral reefs cover less than one percent of the ocean floor! If we take a closer look at the coral in reefs we would find stony coral and soft coral. Both types of coral are made up of individual organisms called **polyps**, but vary slightly. On the next page we will provide more information about polyps and their anatomy.



STONY CORAL	SOFT CORAL
<p>Hermatypic – Reef Building</p> <p>After thousands of years, the accumulation of new growth on old coral skeletons of stony coral is what actually forms coral reef structures</p>	<p>Ahermatypic – Does not build reefs but is found in coral reefs</p>
<p>Polyp with tentacles in multiples of 6</p>	<p>Polyp with only 8 tentacles</p>
<p>Corallite – hard calcium carbonate cupped skeleton.</p> <p>Coral is difficult to identify unless corallite is examined.</p>	<p>Sclerites – thin, spiny pieces of calcium carbonate</p> <p>Coral is difficult to identify unless sclerites are examined.</p>
<p>Zooxanthellae – Always present unless coral is dying. (see next page for more information on zooxanthellae)</p>	<p>Zooxanthellae – sometimes present, coral must rely on itself to make food not the algae.</p>

General Anatomy of a Polyp

Polyps belong to the class **Anthozoa**. Anthozoa is the largest class of the phylum Cnidaria and also includes jellyfish, anemones, and more. **Polyps** are tiny, simple organisms with limited organ development and **radial symmetry** (body parts arranged around a central axis). There are two basic structural features found in all coral polyps: a simple **gastrovascular cavity** (stomach) that has one opening (mouth) and a ring of **tentacles** around the mouth.

The tentacles are extensions of the body that help the coral capture prey, clear away waste, and defend itself. The tentacles and epidermis (outer layer of the organism) contain stinging cells called **nematocysts**. These cells help capture prey and defend against predators, but the sting of most corals has no harmful effect on humans.

Another unique cellular feature is algae called **zooxanthellae** found in the cells of stony corals and a few soft corals suggesting a symbiotic relationship. **Symbiotic** means a mutually beneficial relationship between different organisms. The coral provides the algae a safe environment and the carbon dioxide and nutrients to perform for photosynthesis. In return, the algae helps the coral remove waste and provides oxygen and nutrients from the photosynthesis process.

Photosynthesis is when green plants process sunlight, water and carbon dioxide to synthesize nutrients, chlorophyll and oxygen. The algae also produce pigments that are visible through the clear body of the polyp and give coral its beautiful color.

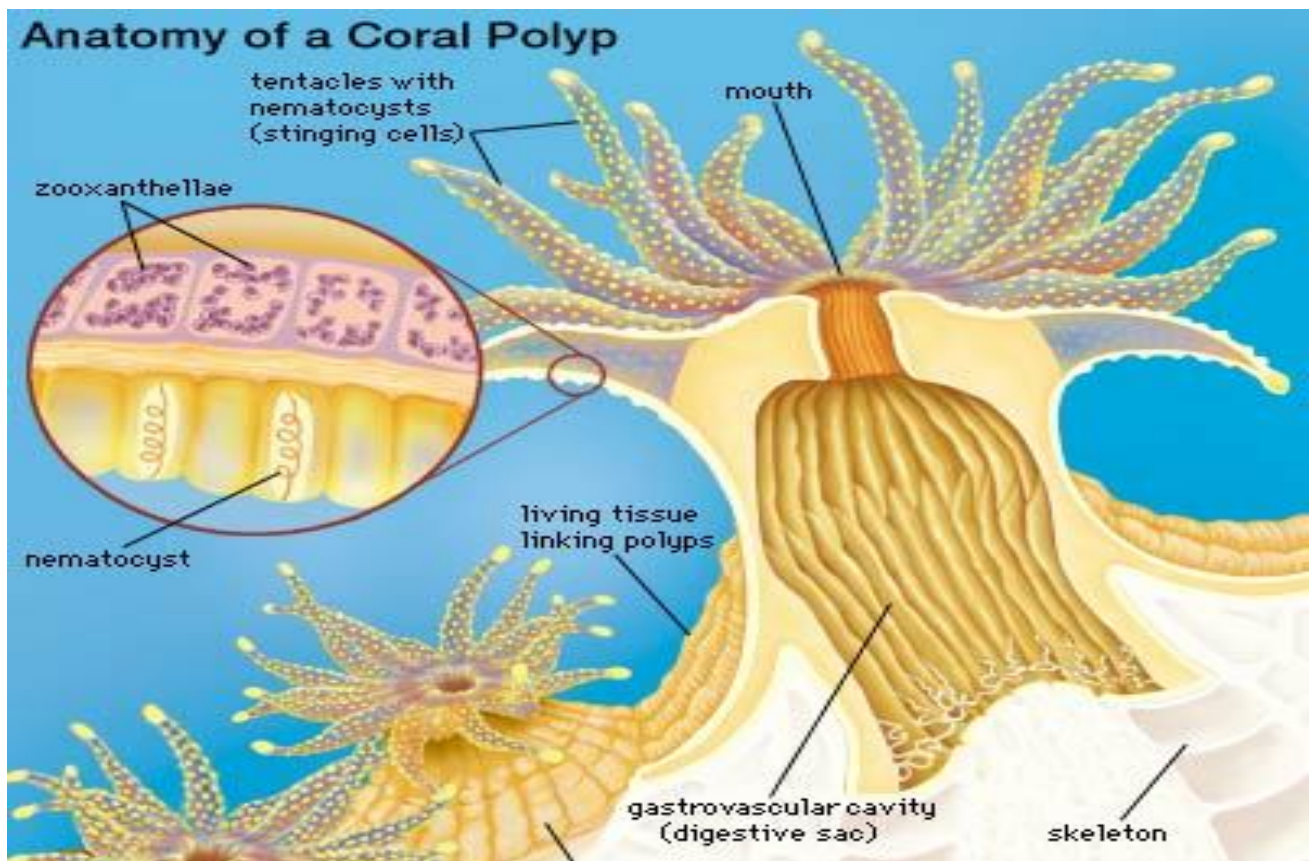


Figure 1: Anatomy of a stony coral

Coral Life Cycle

Coral species can reproduce via asexual or sexual reproduction. **Asexual reproduction** is the creation of a new organism from a single organism. This can occur in multiple ways but in **budding**, new polyps bud or split off from parent polyps to form new colonies. In **fragmentation**, an entire colony (rather than just a polyp) branches off to form a new colony. This is often seen when a large colony is broken off from the main colony during a storm or by boat damage.

Sexual reproduction is the creation of a new organism from organisms that produce mature reproductive cells. Broadcast spawning and brooding are examples of sexual reproduction.

75% of stony corals reproduce with an external fertilization called **broadcast spawning**. This is when many corals release reproductive cells, called **gametes**, into the water at the same time. The gametes spread in the water and fertilize with another polyp's gametes. **Fertilization** is the reproductive cells (gametes) coming together to form a new organism or larvae called **planula**. If fertilization occurs inside the gastrovascular cavity of the coral it's referred to as **brooding**. Coral brooding species only release male reproductive cells into the water to find an egg-carrying coral.

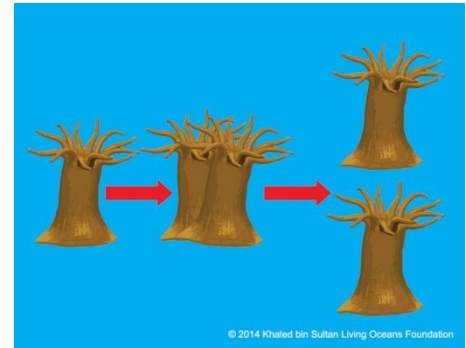


Figure 2: Coral Budding



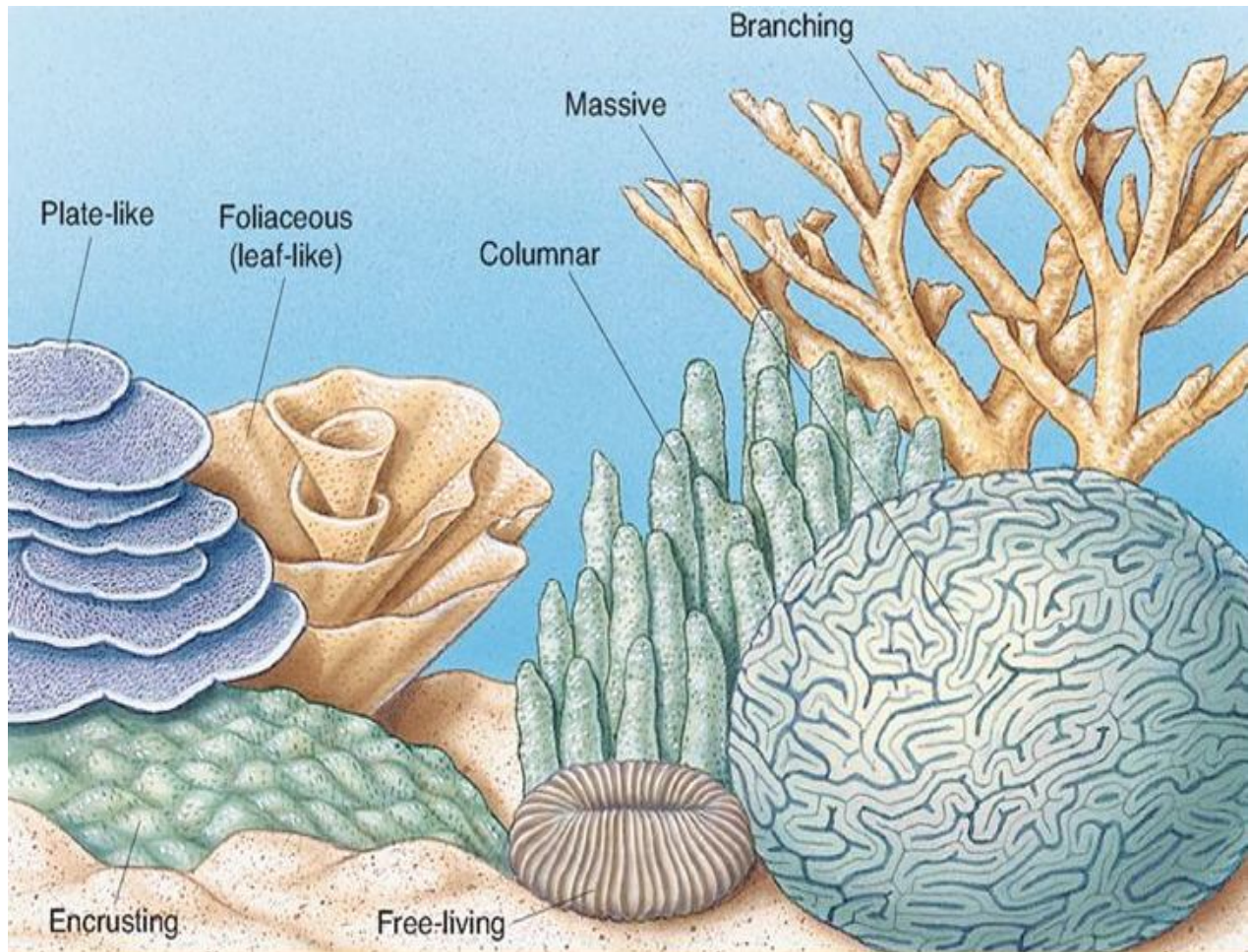
Figure 3: You see all of those tan dots? Those are gametes during a mass spawning event!




Since corals do not move, the timing of the broadcast spawning event is very important. All coral species need to know when to release their gametes for successful reproduction. Below are some environmental conditions that affect when spawning occurs:





- Geographic location (Reefs around the world spawn at different times)
- Weather
- Warm sea temperature
- Salinity (concentration of salts in the water)
- Currents and Tidal cycle
- Length of day and lunar cues (Spawning seems to occur just after a full moon)
- Chemical signaling

Types of Corals

On page one, two types of coral were discussed: **stony corals** and **soft corals**. Stony corals are reef building corals and can grow in different forms and shapes: **Branching, Columnar, Foliaceous, Massive, Encrusting, Plate-like, and Free-living**. The shape of the coral reef depends on the species and location. For example, in areas with strong waves corals tend to grow into mounds or flattened shapes (i.e. encrusting or massive). In more calm or sheltered areas, species may grow into more intricate shapes (i.e. branching). On the next page each coral form is listed with a description and species example.



Form	Description	Species
Branching	Branching with secondary branches	 <p data-bbox="816 638 1459 688">Staghorn Coral (<i>Acropora cervicornis</i>)</p>
Columnar	Finger-like forms	 <p data-bbox="829 1079 1446 1129">Pillar Coral (<i>Dendrogyra cylindricus</i>)</p>
Foliaceous	Broad, thin leaf-like structures clustered together	 <p data-bbox="813 1556 1459 1606">Cabbage Coral (<i>Turbinaria reniformis</i>)</p>

<p>Massive</p>	<p>Dome-shaped boulders</p>	 <p>Boulder Brain Coral (<i>Colpophyllia natans</i>)</p>
<p>Encrusting</p>	<p>Grows as a thin layer on substrate; lichen-like in appearance</p>	 <p>Disc Coral (<i>Turbinaria stellulata</i>)</p>
<p>Plate-like</p>	<p>Flat upper surface giving table appearance</p>	 <p>Brush Coral (<i>Acropora hyacinthus</i>)</p>
<p>Free-Living</p>	<p>Solitary polyps that do not form colonies</p>	 <p>Mushroom Coral (<i>Fungia fungites</i>)</p>

Soft corals belong to the extremely varied group **Octocorallia** which also includes sea fans, sea whips, and others. They are also found in various shapes, forms and colors and look like fleshy, colorful plants, trees, and grasses.

Carnation Tree Coral
(*Dendronephthya* sp.)



Toadstool Coral
(*Sarcophyton glaucum*)



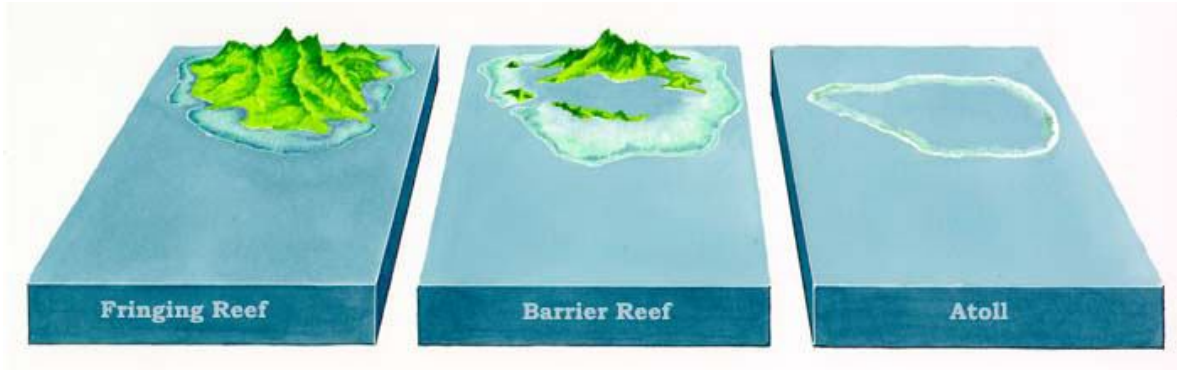
Finger Leather Coral
(*Sinularia notanda*)



Types of Coral Reefs

There are 3 types of coral reef systems: fringing, barrier, and atoll.

- **Fringing:** The coral reef is directly attached to the mainland/island shore.
- **Barrier:** The coral reef is separated from the mainland/island by a channel.
- **Atoll:** The coral reef is continuous, encircling a lagoon.



Example of a Fringing Reef:



Ningaloo Reef

Location: West Coast of Australia in the Indian Ocean

Example of a Barrier Reef:



Belize Barrier Reef

Location: Off coast of Belize in the Caribbean Sea

Example of an Atoll Reef:



Ari Atoll

Location: Maldives in the Indian Ocean

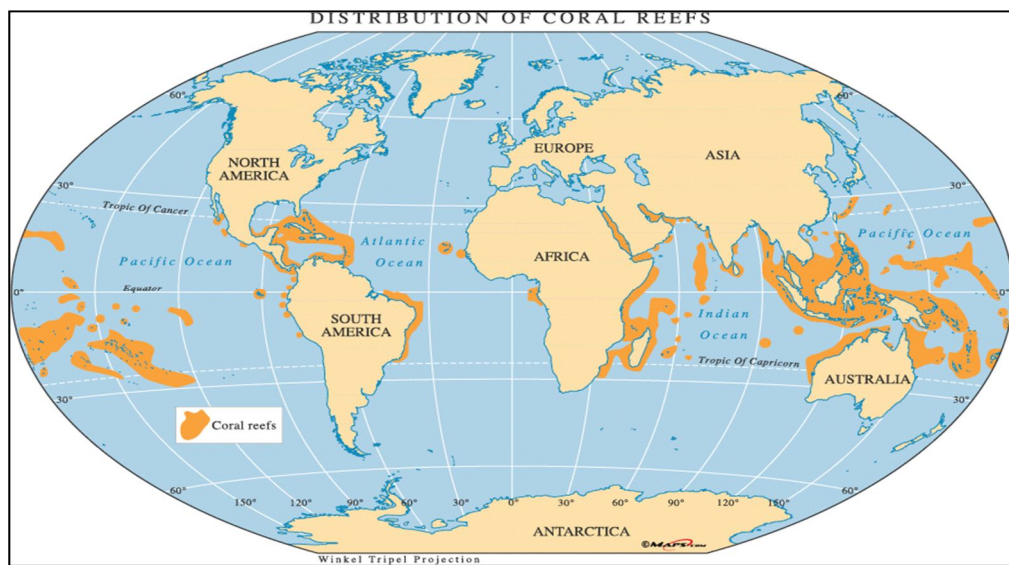
Where Can You find Coral Reefs?

Coral reefs have extremely high biodiversity, but they are limited to one-sixth of the world's coastlines. Coral reefs have specific environmental conditions required for healthy development. These conditions include: water depth, water clarity/sedimentation, water temperature, water movement, and salinity. These conditions are not only important for the coral but the symbiotic relationship with algae as well (Refer to page 2: zooxanthellae for more information)

- **Water Depth:** Algae cannot complete photosynthesis if the water is too deep. Water depth must be less than 230' deep.
- **Water Clarity/Sedimentation:** Algae cannot complete photosynthesis if the water is murky because it cannot get enough light. Sediment on coral reefs will slow or stop growth because it prevents feeding and respiration.

- Water Temperature: Should fall within the range of 77°F to 84°F. Waters that are too cold effect reproduction and waters that are too warm lead to coral bleaching. Learn more about bleaching on page 10.
- Water Movement: Locations near ocean currents are ideal because the currents help relieve reefs of any sediment, and they also carry in plankton for feeding.
- Salinity: Is the amount of salt dissolved in a body of water. Corals require a higher level of salinity to survive which is why coral reefs do not develop at **estuaries** or areas freshwater runs into the ocean. The Mississippi River is an example of an estuary.

It is because of these specific conditions that coral reefs are mostly limited to the tropical oceans between latitudes approximately 30° north and 30° south of the equator, with a few exceptions.



Coral Reef Ecosystem

There are thousands of plants and animals that rely on the coral reef: algae, corals, crustaceans, mollusks, sponges, fish, sea turtles, sharks, dolphins, and many more. Approximately one-fourth of all marine life relies on coral reef at some point in their life, making coral reefs absolutely essential to marine life. All components of a coral reef are interconnected, so if the reef undergoes a drastic change, it could impact the abundance and diversity of all species that rely on the ecosystem. Here are a few more examples of coral reef relationships:

- Some fish specialize in eating and clearing algae that could smother the reefs. For example, the **Parrotfish** eat algae off coral and nibble on dead coral, grinding up the skeleton and excreting it as sand.
- Large predatory fish keep the population of smaller fish in balance.
- “Cleaner” fish and shrimp clear other fish of parasites.
- Coral reefs provide a variety of camouflage and other hiding spots for living creatures.
- Crabs and sea cucumbers eat detritus (waste or debris) from the reef and ocean floor.

- Anemones provide a home and nesting ground for clown fish, and the fish provides the anemone with nutrients and protection from predators.
- And many more!

Threats to Coral Reefs

Seventy-five percent of the remaining coral reefs are threatened. Threats to coral reefs are listed below:

- **Warming Waters** – Warm water can also allow for disease-causing organisms to grow quickly, and the coral can get sick. Warm temperatures of the water can also affect the coral and algae relationship. If water temperature is too high or too low, the coral will expel the zooxanthellae. This action is called **bleaching**. Without algae pigment the coral look white and is a clear sign of stress.



Figure 4: Without the help of algae, not only will the coral suffer but the entire diversity of the reef.

- **Ocean Acidification** – Coral reefs to play a role in carbon sequestration, but as levels of carbon dioxide in the air increase, oceans absorb the additional carbon dioxide increasing acidity in the ocean. Acids dissolve coral skeletons and prevent new growth.
- **Land-based Pollution** – This includes but is not limited to: sewage, sedimentation, and industrial waste. The increased nutrient levels allow macroalgae to overgrow and cover coral preventing them from receiving sunlight that is essential for life. Corals have trouble shedding sediment and it prevents feeding and respiration.
- **Overexploitation** – Corals, fish, and other sea animals (turtles, sharks, etc.) are being taken from reefs for trade, food, aquarium pets and décor. The loss of animals from a habitat can have negative impacts on the food web and ecosystem. Coral is frequently taken as a souvenir or aquarium décor.

- **Destructive Fishing Methods** – Blast fishing and cyanide fishing are types of methods used by fishermen that are dangerous for wildlife. These methods stun or kill the fish, so they can be collected easily. Blast fishing can completely crumble a reef structure and corals cannot escape the “cyanide cloud.” The cyanide cloud can interfere with the zooxanthellae photosynthesis as well.



Figure 5: The remains of a coral reef after blast fishing

Coral Reef Conservation

Why should we protect and conserve coral reefs?

- Corals reefs are some of the most diverse ecosystems, and they provide homes to approximately one-fourth of all marine species.
- Coral reefs also help protect the coastlines by acting as a buffer from waves and storms.
- Coral reefs provide billions of dollars of food and jobs via fisheries and tourism.
- Coral reef plants and animals are used in the production of new medicines for cancer, arthritis, bacterial/viral infections, Alzheimer’s disease, heart disease, and other diseases. Some scientists claim there are possibly thousands if not millions of undiscovered species in the ocean that could be key to new medical discoveries.
- Coral reefs do play a role in the carbon cycle, helping decrease carbon dioxide in the air.

What is being done to protect and conserve coral reefs?

- Many scientists say if coastlines can increase Parrotfish populations, they are the key to saving the coral reefs.
- **The Coral Reef Task Force (CRTF)** was established in the United States in 1998 to protect and conserve coral reefs by establishing many partnerships and passing resolutions all parties agree upon.
- The United States Department of Commerce’s **National Oceanic and Atmospheric Administration (NOAA)** has a program called the **Coral Reef Conservation Program** created by the **Coral Reef Conservation Act of 2000**.
 - They focus on the top three threats to coral reefs: climate change (warming waters and ocean acidification), land-based pollution, and destructive fishing methods.
 - The Coral Reef Conservation Program works with NOAA scientists to study and understand the complex ecosystems and implement better management of coral reefs.



Figure 6: Islands in the Caribbean are boosting efforts to increase Parrotfish populations.

- **The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** regulates the international import and export of sea animals and plants.
- **Marine Protected Area (MPA)** are areas that are monitored, managed and sometimes restricted to prevent damage from activities like fishing and diving. MPA's are not limited to coral reefs, but can include preserved shipwrecks, cultural sites, marine refuges and more.
- And many others...

What can YOU do to help?

- If you go scuba diving, practice safe diving techniques – do not sit, stand, or touch coral.
- If you plan on setting up a marine aquarium, purchase captive-raised sea animals. Do not support businesses that capture animals from the wild.
- Support sustainable fishing practices by eating certified seafood.
- Reduce carbon dioxide emissions that affect the environment by: using alternative types of transportation, turning off lights and other electronics when not in use, and recycling (cans, glass, plastics, and paper).
- Do not purchase souvenirs made from items/animals collected from the sea (coral, sea stars, etc.)

Coral Reef Fun Facts

- Some coral reefs today are over 50 million years old!
- It is estimated that more than 1 million species of plants and animals are associated with the coral reef ecosystem!
- The **Great Barrier Reef** located off the northeastern coast of

Australia is the world's largest coral reef and one of the seven natural wonders of the world. The reef is made up of 3000 reef systems and is the only living organism that's visible from space. The Great Barrier Reef Marine Park was founded in 1975 by the Australian Government to protect and conserve a large portion of the reef.

- Artificial reefs are manmade structures that are put

underwater to attract marine life and tourism. In 1986, a ship called the *Thunderbolt* was

intentionally sunk as part of the Florida Keys Artificial Reef Project. *Thunderbolt* is one of nine ships lying on the ocean floor of the Florida Keys as part of "Shipwreck Trail."

- Coral Reefs are called the "Rainforests of the Sea." Aren't they pretty?



Figure 7: The Great Barrier Reef from space.

