What's happening to the Corals: Coral Reef Diversity

Objective

This lesson introduces students to coral reef ecosystems and describes the biology of corals. Students will learn what makes up a coral and why it is important for oceans. They will also learn about the diversity of coral reef ecosystems and think about relationships. They will investigate ocean relationships and take part in hands on activities that allow students to think about how organisms are adapted to parts of their environment.

Time needed

Prep time: 30 minutes

Class time: 2 Hours

Materials

Part 1. What is a Coral?

- Pictures of corals on PowerPoint Slide (provided)
- Coral Worksheet – Plants vs. Animals
- Latex Gloves

Part 2. Diversity of the Oceans Activity

- Laminated pictures of reef organisms
- Laminated pictures of coral organisms

Background Information

Corals are animals that belong to the phylum Cnidaria, which contains sea anemones, jellyfish, hydra, and corals. The name "Cnidaria" comes from the Greek word "cnidos" which means stinging cell. The tentacles have specialized stinging structures called nematocysts that are used for protection and to capture prey. The tentacles bring food into the animal's one opening, which is used both to take in food and to expel waste materials. The coral animal, made up of its tube-shaped body, its tentacles, and its mouth, is called a coral polyp.

There are two main types of corals: hard corals and soft corals. Hard corals and some soft corals contain zooxanthellae within their tissue. Zooxanthellae are marine algae, some of which are free living and some of which live inside the translucent, fleshy tissue of many corals and other marine organisms. Zooxanthellae that live in marine animals have a mutually beneficial symbiotic relationship with their host. This means that both the coral and the alga benefit from being in the relationship. The zooxanthellae photosynthesize from within their coral host and produce sugars

that provide nutrition to both the zooxanthellae and the coral. In return, the coral provides protection and assists the growth of the zooxanthellae by passing on some of its waste, which the zooxanthellae use as a nutrient source. It is the colorful zooxanthellae that give coral their different colors and because zooxanthellae need sunlight to perform photosynthesis, they are the reason why corals need sunshine to survive.

If coral is affected by an environmental stress such as increased temperature or sedimentation, the zooxanthellae leave the coral and the coral turns white. This is termed coral bleaching. Although zooxanthellae can live freely in the water without coral, corals that normally contain zooxanthellae in their tissue cannot survive for long without their symbiotic algae. They will slowly starve. Thus, coral bleaching can be lethal for the coral if the coral polyps do not reacquire zooxanthellae. The phenomenon of coral bleaching is of particular concern as sea surface temperatures rise with human-induced climate change.

Phylogenetics, or **Cladistics**, is the study of evolutionary relationships among a set of taxa. Evolution is the descent of living **taxa** (singular= taxon), or formally-named groups of organisms, from a common ancestor whereby the taxa share similar characters. These **characters** are traits or features that vary among a set of taxa (e.g. hair color) and a **character state** is a variant of the character that occurs in a particular taxon (e.g. black hair). Through the evolutionary process of descent with modification, biological populations are altered over time and may diverge into new populations or go extinct.

This divergence of a population is called **lineage splitting** and occurs when populations become isolated from one another and no longer able to exchange traits via sexual reproduction. There are two types of traits that occur in diverging lineages. Most traits are carried over through the new population and are referred to as **ancestral traits**. However, evolution acts on this diverged population causing some characters or traits changes from the ancestral state and become a **derived traits**.

Engage

Students can be drawn into these activities by their interest in marine coral species and the relationships that exist between organisms. What corals are and what makes them so important for ocean ecosystems is something that will trigger student curiosity. Also the connections between climate change and coral health is something that may also interest students.

Explore – What is a Coral?

Experiment Questions:

1. Is a coral a plant or an animal?
2. What makes up a coral?
3. What is a zooxanthellae and what kind of relationship does it have with a coral?
4. What makes a coral an animal?

Procedure:

1. Ask students, "How many of you think coral is a plant? How many of you think coral is an animal?"
2. Corals are animals! Go over some of the big differences between plants and animals. Make a table on the board.

   Plants

   Plants use the sun's energy to make food through a process known as photosynthesis.
   Only plants have roots, stems and leaves.
   Plants generally do not move from one place to another.
   Plants have chlorophyll in their cells to capture light energy.
   Plant cells have walls.

   Animals

   Animals cannot produce their own food from the sun and must eat other organisms in order to get food and energy.
   Animals do not have roots, stems and leaves.
   Animals generally can move to catch food.
   Animals do not have chlorophyll in their cells.
   Animal cells don't have walls and their cells are more flexible and variable in shape.

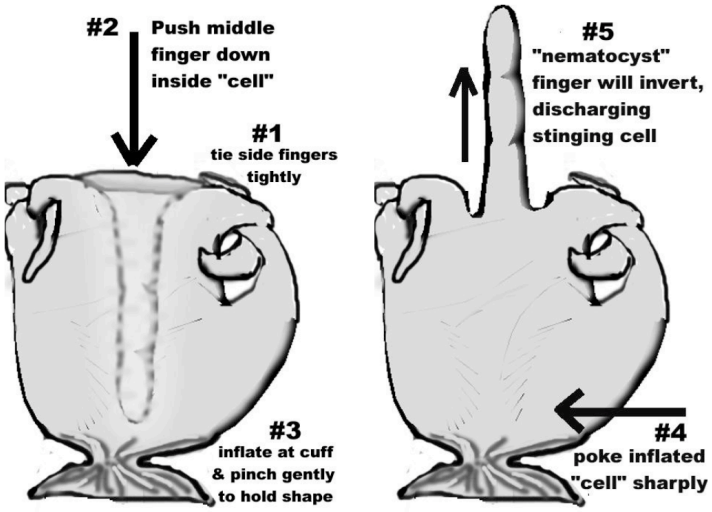
3. Show students a diagram of a coral and discuss all of the labeled parts: tentacles, nematocysts, *mouth, gut, skeleton, and zooxanthellae.*

4. Describe what zooxanthellae are, their role and interaction with corals and why they are important for the health of a coral organism.
   *Zooxanthellae are marine algae, some of which are free living and some of which live inside the tissue of many corals and other marine organisms. Zooxanthellae that live in marine animals have a mutually beneficial **symbiotic** relationship with their host. This means that both the coral and the alga benefit from being in the relationship. The zooxanthellae photosynthesize from within their coral host and produce sugars that provide nutrition to both the zooxanthellae and the coral. In return, the coral provides protection and assists the growth of the zooxanthellae by passing on some of its waste, which the zooxanthellae use as a nutrient source.*

5. Ask students, "What makes a coral polyp an animal?"
   It eats other organisms by capturing them with its tentacles. It does not have plant parts. It cannot make food from the sun's energy without the help of zooxanthellae.

6. Corals catch their prey with tentacles and use stinging cells called nematocysts! Have each student take a latex glove and blow it up. Tie the end so no air escapes.

7. Push one finger down and then poke the glove, or "cell" sharply.



8. The finger, or nematocyst, will pop out! This demonstrates the discharging of the corals' stinging cells to catch prey.

9. Have a discussion about how corals catch their prey using these nematocysts. Feel free to show a video of this! (there is one provided at the end of the powerpoint!)

10. Discuss with the students other cnidarians – jellyfish, anemones and other coral species.

11. Optional: After you have discussed all the parts of a coral, use the Coral Quiz Worksheet provided to quiz them on the information they learned!

Explore – Diversity of the Oceans Activity

Experiment Questions:

1. What is a phylogenetic tree?
2. What relationships do certain corals have to each other?

Procedure:

1. Explain the students what a phylogenetic tree is. Use the PowerPoint slides provided!
   A phylogenetic tree is a diagram or "tree" that shows relationships between organisms – based on similarities or differences in physical or genetic characteristics.

2. Using the PowerPoint slides provided, explain the various morphological characteristics that cnidarians possess.
   ***Polyp** – mouth opens up, typically don't move and they are sit and wait predators – corals and anemones have polyps*
   ***Medusa** – mouth opens down, mobile hunters - jellyfish have the medusa shape*

Colonial Organisms *– collection of identifcal individuals that function together as one organism – corals are a great example of colonial organisms*
Solitary Organism *– made up of one individual – anemones are a great example of solitary organisms.*
Pigmentation *– some cnidarians display brilliant colors while other lack any pigmentation. Some cnidarians have it while others lack pigmentation. The pigmentation is provided by the zooxanthellae that live inside.*

3. Break students into groups of 4-5.

4. Using the morphological characteristics described, have the students look at the pictures of the various cnidarians and choose one morphological characteristic to create a phylogenetic tree.

5. Have the groups of students arrange the pictures into a phylogenetic tree based on the morphology they chose above of the various pictures.

6. Once everyone has completed arranging their tree, have students present their tree and have them describe why they chose to arrange it that way.

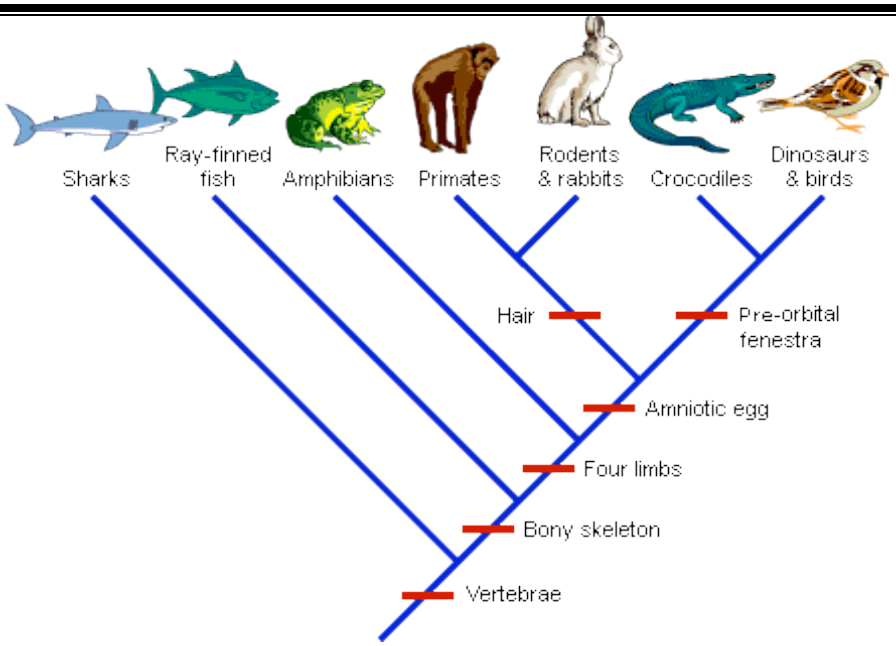
7. Once everyone has explained their tree, ask, "Is every group's tree the same?"
   The answer should be no.

8. Ask the students why they think this is.
   There is no one right phylogenetic tree and the relationships described are all a ***Hypothesis!***
   There is no one right answer!

Explain

Students will learn a great deal about coral organisms and relationships between corals and other cnidarian species.

If students are confused or don't understand the concept of phylogenetic trees, use the following example:



In this example, you can see the various animals at the tips of the tree and the branches below indicating relationships between each animal. At each node, there is a split that occurs. This split means that there was a new characteristic introduced, or "evolved". In this example, the trait that all the animals share is a "Vertebra". Then as you move up the tree, new characters are introduced and only a certain number of animals have that trait. "Vertebrae" is considered an ancestral trait, whereas "Hair" is a fairly newer trait that evolved in just a subset of animals. Using these morphological and physical characteristics, or traits, we can make predictions about relationships and when animals evolved.

In our example of cnidarians, students should understand that corals are the most complex organisms because they have a variety of more complex traits – pigmentation, colonial organization, and polyp lifestyles. Whereas a jellyfish is not necessary pigmented and is has a medusa body shape. Understanding these relationships will help students understand how the ocean has evolved into a very complex ecosystem! Also, they should understand how relationships are examined and the evolutionary relationship between various morphological characteristics of cnidarians.

Elaborate

Student can expand their learning from these activities by thinking about invertebrates or vertebrates in the ocean and what particular characteristics they have that allows them to thrive and survive in their environment. Students can think about adaptations that allow organisms to call the ocean home. Students can also apply their understanding of phylogenetic trees and relationships to other organisms, whether if be aquatic organisms or land organisms. They can form hypotheses about the evolution of particular traits and species.

Resources

Additional Resources

http://marinebio.org/oceans/coral-reefs/

http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/what_is_a_coral/

Resources Used:

http://www.sea.edu/academics/k-12_detail/specialized_for_the_sea

http://www.calacademy.org/educators/lesson-plans/build-a-coral-polyp

Coral Quiz Worksheet

1) Draw a diagram of a coral polyp and label five parts.

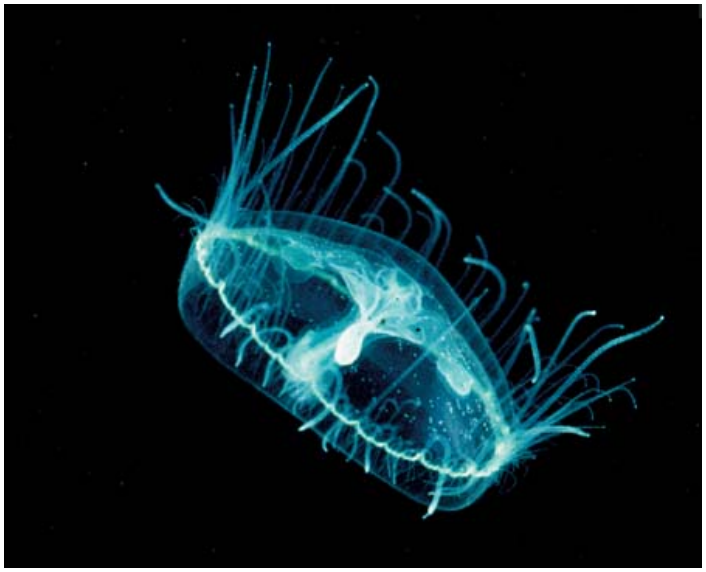
2) What are the zooxanthellae in corals?

3) What two things do zooxanthellae produce that aids the animal?

4) The stinging cells in cnidarian tentacles are called _____?

5) A coral skeleton is made of what chemical compound?

6) True or false? Corals are plants. _____



Craspedacusta sowerbyi

Freshwater Jellyfish

Clava multicornis

Hydra magnipapillata

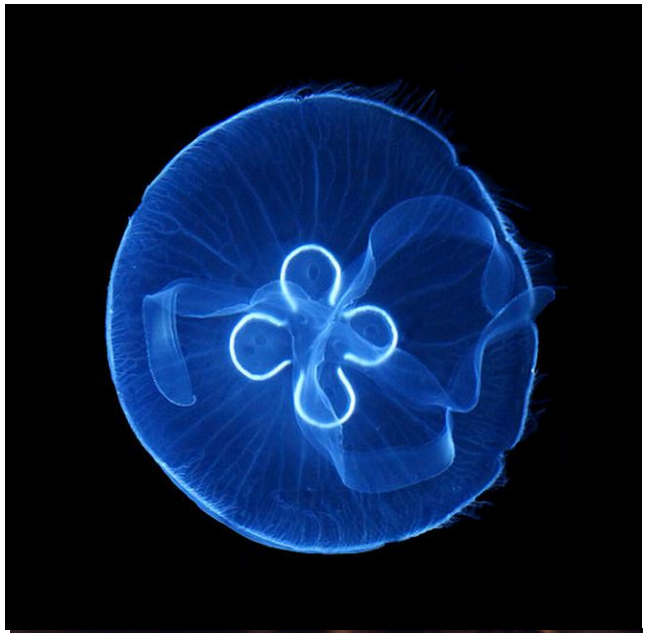
Marrus sp.

Cassiopea frondosa

Upside Down Jellyfish

Aurelia aurita

Moon Jelly

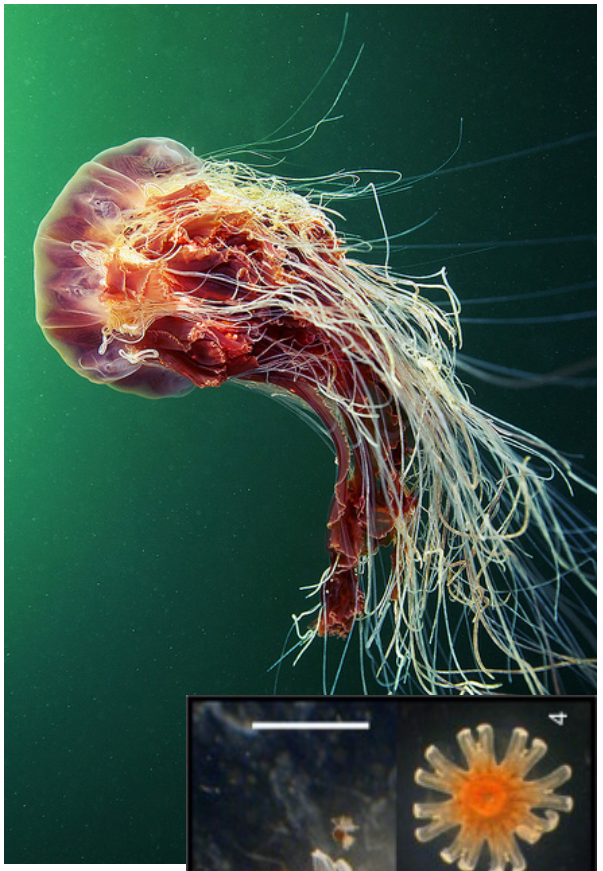


Haliclystus sanjuanensis

Stalked Jellyfish

Catostylus mosaicus

Jelly Blubber



Cyanea capillata

Lion's Mane Jellyfish

Acropora tenuis

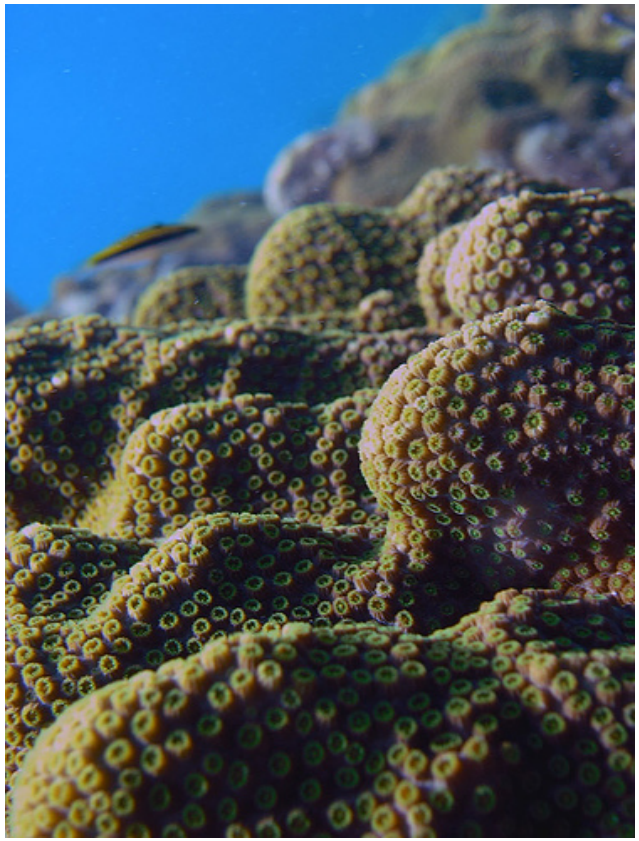
Staghorn Coral (Hard Coral)

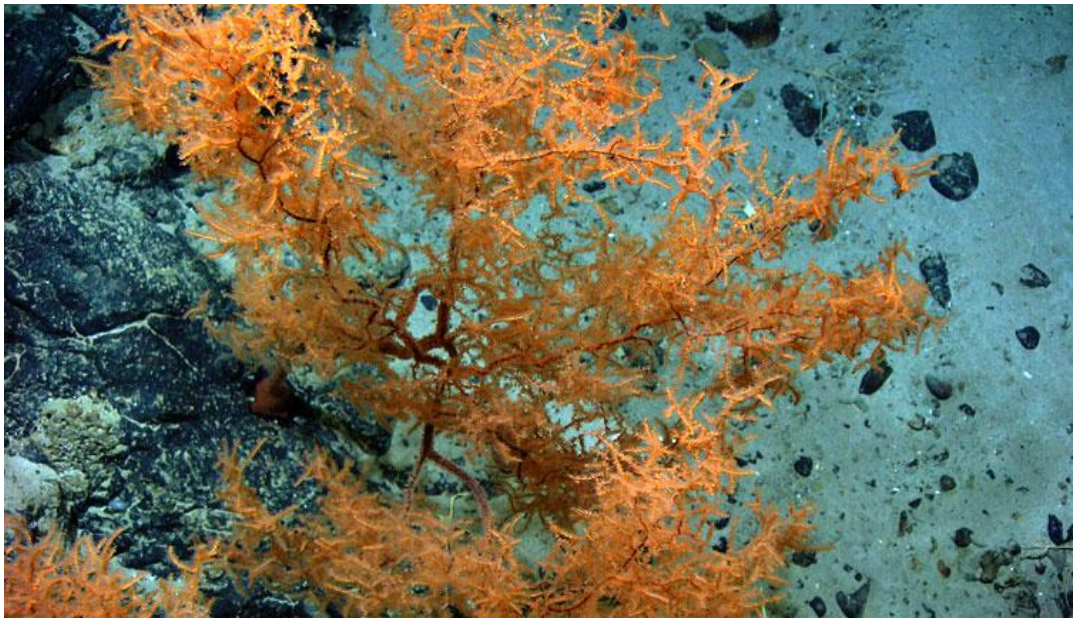
Porites okinawensis

Hard Coral

Montastraea faveolata

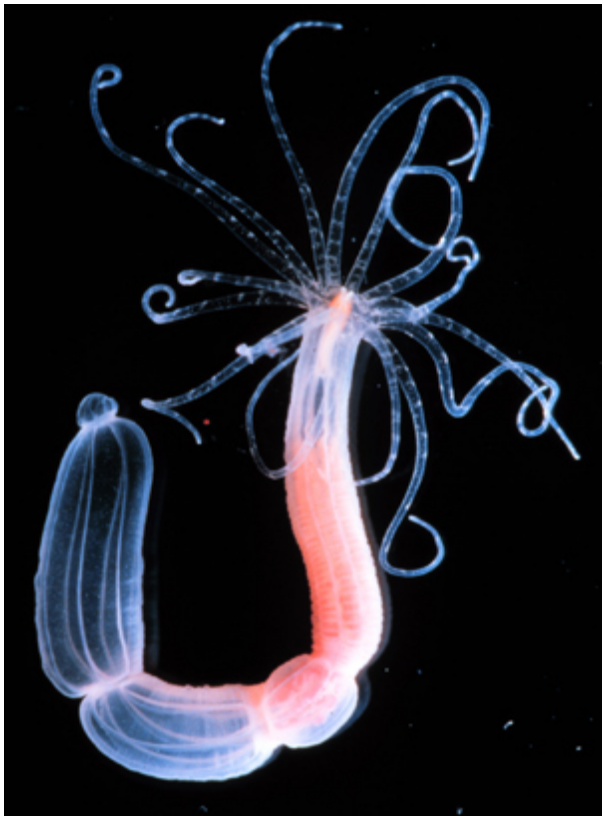
Hard Coral





Leiopathes glaberrima

Black Coral

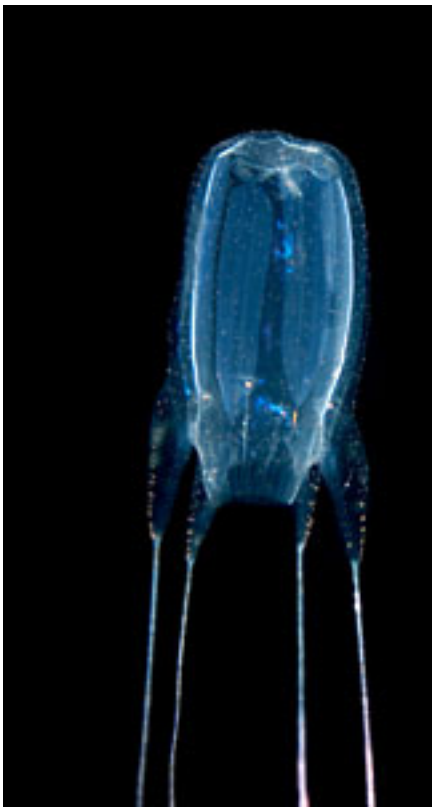


Nematostella sp.

Starlet Sea Anemone

Metridium senile

Plumrose Anemone



Alatina moseri

Winged Box Jellyfish

Pseudopterogorgia bipinnata

Purple Sea Plume

Sarcophyton glaucum

Common Toadstool Coral