

# Growing Coral

## Objective:

Students will observe the growth of crystals that develop in a way similar to how coral polyps create their calcium carbonate cups.

## Materials:

plastic bowls (have students bring from home)  
pieces of charcoal, porous brick, tile,  
cement, or sponge  
water  
table salt (iodized or plain)  
liquid bluing (found with bleaches at grocery stores)  
food coloring  
measuring tablespoons  
masking tape  
pens  
ammonia (to be handled by an adult)  
sugar  
clear glass

## Action:

1. Ask students to label their bowl with pieces of masking tape with their names on them. Have them put some pieces of charcoal, brick tile, sponge, or cement into their bowls.
2. Students should pour two tablespoons of water, two tablespoons of salt, and two tablespoons of liquid bluing over the base material (charcoal, etc.). Set bowls on a table or counter top. Formations need free air circulation to develop.
3. The next day have them add two more tablespoons of salt.
4. On the third day, pour in the bottom of the bowl (not directly on the base material) two tablespoons each of salt, water, and bluing, then add a few drops of food coloring to each piece of base material.
5. A crystal formation should appear by the third day. If not, it may be necessary to add two tablespoons of household ammonia to aid the growth. **(Only teachers or other adults should handle and add the ammonia).** To keep your formation growing, just add more bluing, salt, and water from time to time.
6. Ask students to describe what they think happened between the bluing, water, and dissolved salt to create the formation. Explain to students that when the three materials combined, a chemical reaction took place and formed a new substance. Tell them that coral polyps, with the help of zooxanthellae, remove dissolved calcium carbonate from seawater and use it to create the stony cup that protects their soft bodies.
7. Demonstrate the concept of a dissolved substance by pouring some sugar into a glass of water. Ask the students if they can see the sugar. Stir the water vigorously for about five seconds. Ask the students if they can see any of the sugar in the water. Stir the solution again, this time for about one minute, or until all the sugar has dissolved. Ask the students if there is still any sugar in the water. Stress that although they can't see the sugar, it's still there, in dissolved form.

# Weave a Food Web

## Objective:

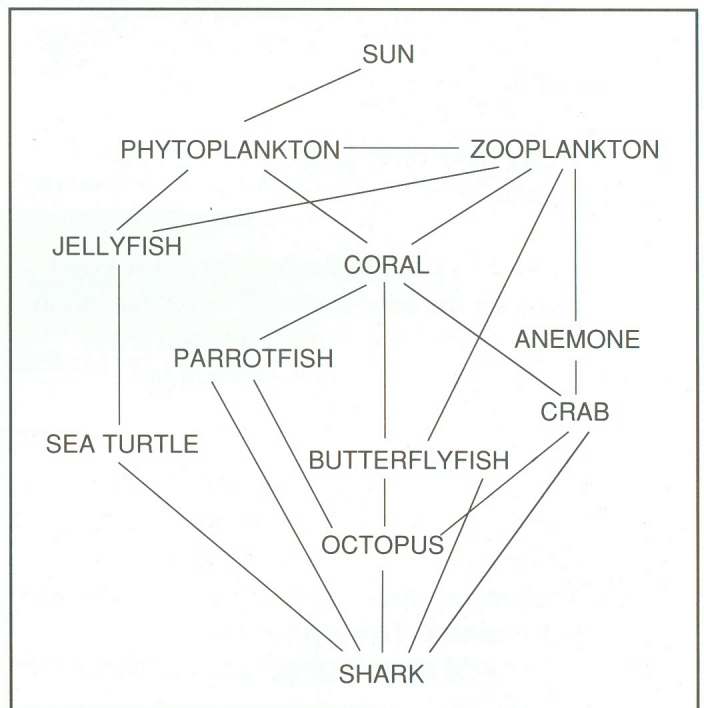
Students will discover the food/energy relationships within a food web in a coral reef habitat.

## Materials:

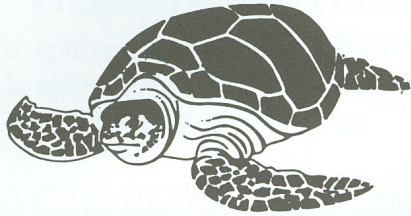
Copies of page 11 enlarged 200% (so that you have one animal for each student)  
yarn or string  
large playing area

## Action:

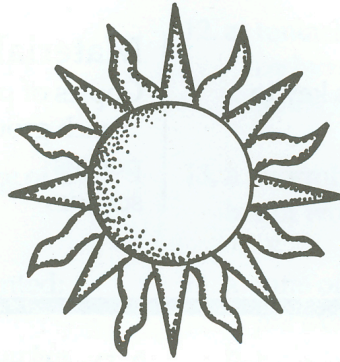
1. Cut out pictures of members of the reef ecosystem and use yarn to create signs students can wear around their necks. (Be sure you only have one sun.) Roll the rest of the yarn into a ball.
2. Define a food web for your students: write the words sun, phytoplankton, jellyfish, and sea turtle on the board and draw pictures to symbolize each one. Share with students the idea that phytoplankton gets its energy from the sun, the jellyfish gets energy by eating the phytoplankton, and then the sea turtle gets its energy by eating the jellyfish. Explain that most animals eat more than one thing. Tell them that the transfer of energy through food between life-forms in an ecosystem is called a *food web*.
3. Take students out to playing area, and have them form a large circle. Give everyone an animal card to wear.
4. Have the person who is wearing the sun card hold one end of the string. Ask students which member of the food web gets their energy from the sun (phytoplankton, a type of plant). As they volunteer answers, unroll the yarn and have students wearing those signs hold onto the yarn. Next, ask students which members of the food web get their energy directly from phytoplankton (coral polyps and zooplankton—refer to diagram on the right side of this page). Have those students hold onto the yarn, too. Continue until the food web is complete.
5. Direct students to gently and carefully lay the yarn on the ground so that web stays intact. Have them step back and notice the pattern created by the interaction of organisms.
6. Explain that many factors can disrupt a food web: pollution, overfishing, and habitat destruction. As you name each factor, use your foot to discreetly disturb part of the yarn web.
7. Have the students pick up the yarn again and ask them if the web looks the same. Explain that many factors including pollution, habitat destruction, and overharvesting resources destroy ecosystems.
8. Instruct students to set the web down again. Ask all corals to take a step back. Have students pick up the web again. Ask students what happens to the food web when an animal becomes extinct.



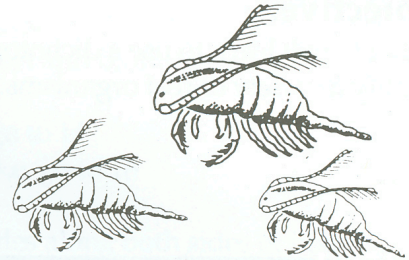
# Food Web Cards



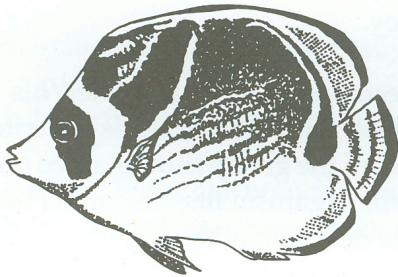
sea turtle



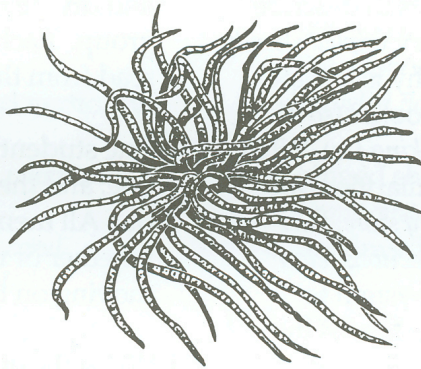
sun



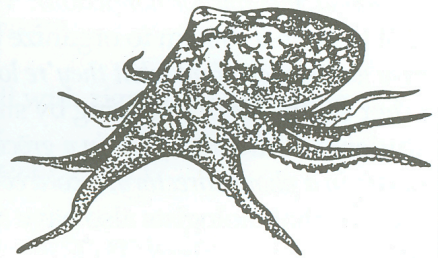
zooplankton



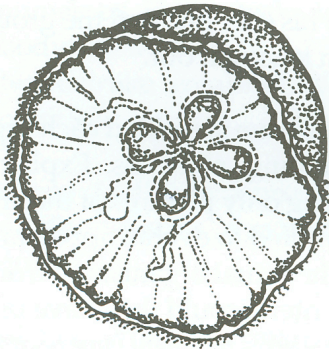
butterflyfish



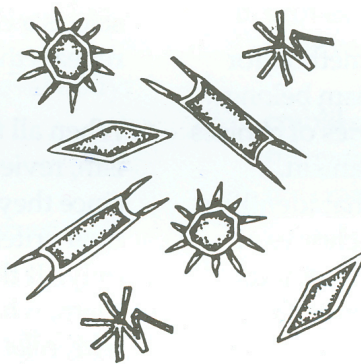
anemone



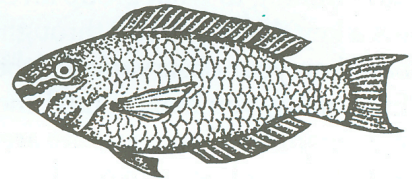
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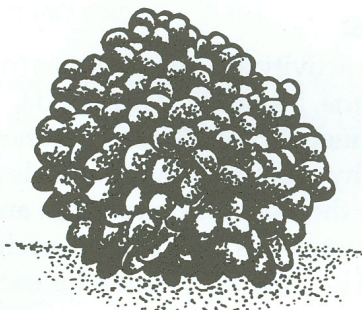
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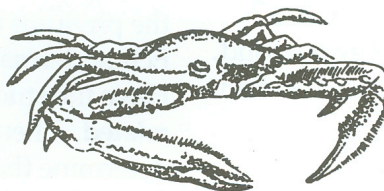
phytoplankton



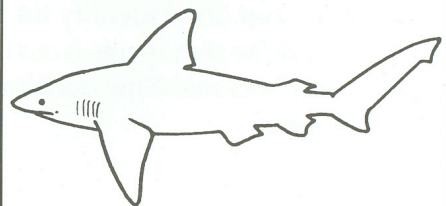
parrotfish



coral



crab



shark

# What's My Name?

## Objective:

Students will learn to use a dichotomous key to identify a variety of reef organisms.

## Materials:

Copies of pages 14 and 15 (one set of pages for each group of four students)

pencils

scissors

## Action:

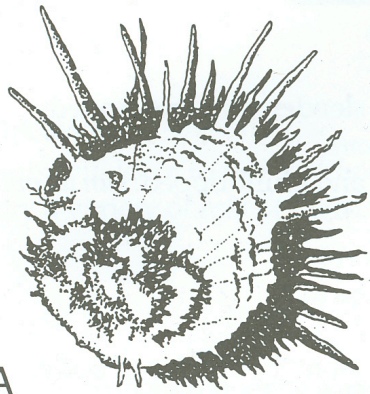
1. Lead students in a discussion about organizing objects into groups based on things they have in common. For example, ask students to describe how books are organized in a library (*alphabetically for fiction, by topic for nonfiction*). Why is it important to have a system to organize books? (*so it's easy for people to find what they're looking for*) What other examples of grouping by similarities can students think of? (*items in a grocery store, businesses in a phone directory, record collections, etc.*) Explain that biologists also have a system to organize living things. It places organisms into groups that have clear-cut similarities. Ask students to name some of the characteristics of birds and to explain why a fish isn't a mammal.  
  
Tell students that there is a scientific method for determining to what group an organism belongs. It's a key that leads you through a series of choices based on your observation of the organism. Eventually, you make a final choice that identifies the organism. Because there are two choices at every step, this system is called a dichotomous key (*di means two, chotomous means branched*).
2. Use an overhead projector to show the picture of the fireworm (card number C) or just hold the card up for the class to see. Demonstrate how the key works by leading the class through two or three steps, but don't identify the creature for them. Read the statements from the key out loud, and let students make the decisions based on their observations.
3. Divide class into groups of four students each. Have students cut out picture cards of organisms and divide them among the members of their group. Each group should select one person to read from the key.
4. One student selects an organism from her/his pile, and the person with the key reads the criteria. All members of the group should agree on whether or not the organism fits the criteria before moving on to the next step of the key.
5. When the organism has been identified, the person whose pile it came from writes its name on the picture and sets it aside. The next person selects a card from his/her pile and the group repeats the steps in keying it out.
6. When all the groups have identified each organism, review their findings as a class. Explain that since they were using only pictures of the animals, their criteria was limited to overall appearance only. If they had the actual organism in front of them, what other criteria could they have used? (*size, color, weight, features that may have been hidden in the drawing*)

## Deeper Depths:

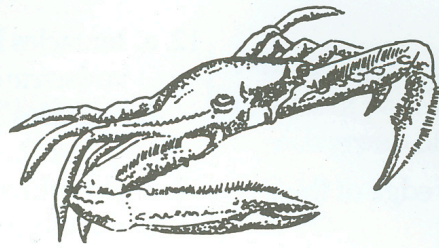
The animals in this activity are invertebrates from the phyla Cnidaria, Mollusca, Arthropoda, Echinodermata, Annelida, and Platyhelminthes. Have the students hypothesize which animals are related. Then have the students do research and determine the characteristics of animals in each of these phyla and identify the phylum for each animal.

# Coral Reef Animal Key

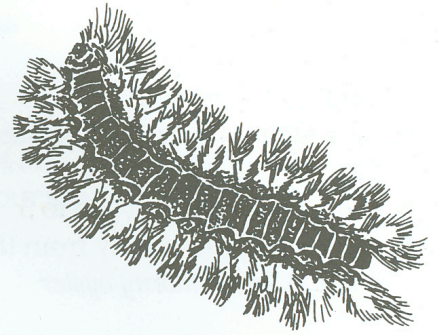
1. a. long spines: go to 2  
b. very short spines or no spines: go to 4
2. a. spines all over body: go to 3  
b. spines projecting only from the edge of the shell: *Atlantic thorny oyster*
3. a. spines are long, thin, and finely pointed:  
*long-spined urchin*  
b. spines shorter and very thick: *club urchin*
4. a. stonelike appearance with branches: go to 5  
b. not stonelike: go to 7
5. a. branches extend horizontally and vertically:  
go to 6  
b. branches only extend vertically: *pillar coral*
6. a. blunt, fingerlike branches: *finger coral*  
b. broad, flat branches: *elkhorn coral*
7. a. transparent: go to 8  
b. not transparent: go to 9
8. a. numerous, fine tentacles line edge of round  
body: *moon jelly*  
b. two hairlike tentacles trail behind oval body:  
*comb jelly*
9. a. five to six distinct arms: go to 10  
b. no distinct arms or more than six arms:  
go to 11
10. a. slender, whiplike arms, spines project from  
sides of arms: *brittle star*  
b. thick, fingerlike arms with blunt tips:  
*comet star*
11. a. numerous tentacles: go to 12  
b. few or no tentacles: go to 13
12. a. tentacles long, slender, and fine-tipped:  
*corkscrew anemone*  
b. tentacles short and blunt-tipped: *sun anemone*
13. a. wormlike: go to 14  
b. not wormlike: go to 16
14. a. tufts of bristles along both sides of body:  
*fire worm*  
b. no bristles: go to 15
15. a. thick, tubelike body resembling a cucumber:  
*soft sea cucumber*  
b. flat, ribbonlike body with smooth edges:  
*polyclad flatworm*
16. a. hinged shell with zigzag shell opening:  
*Frons oyster*  
b. no hinged shell: go to 17
17. a. round body shape: go to 18  
b. body shape not round: go to 19
18. a. five pointed star on surface: *heart urchin*  
b. grooves form wavy pattern on surface:  
*brain coral*
19. a. crablike with prominent front claws:  
*swimming crab*  
b. not crablike: go to 20
20. a. legs: go to 21  
b. no legs: trumpet triton
21. a. long antennae: go to 22  
b. short, flat antennae: *Spanish lobster*
22. a. no spines on body: *rock lobster*  
b. spines on body: *spiny lobster*



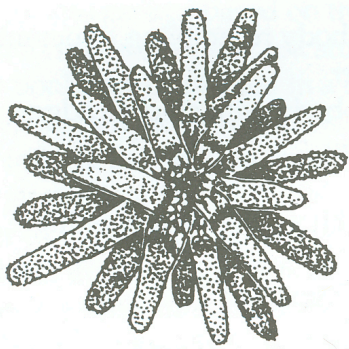
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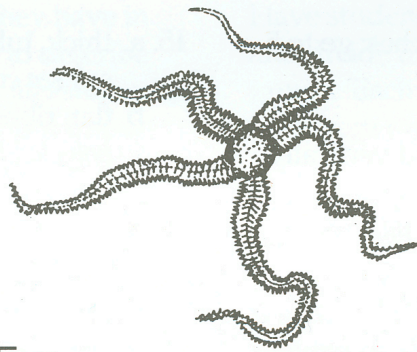
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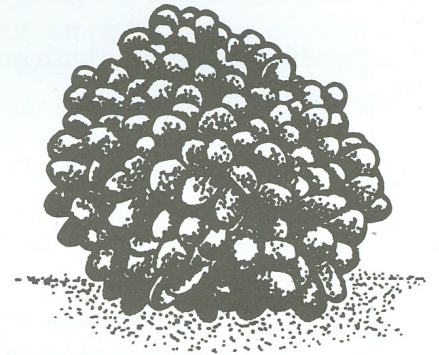
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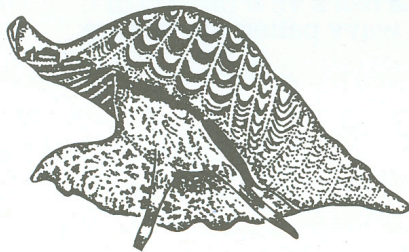
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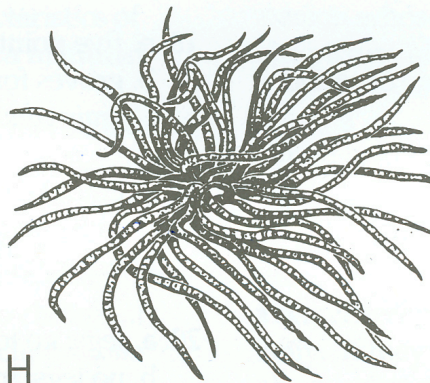
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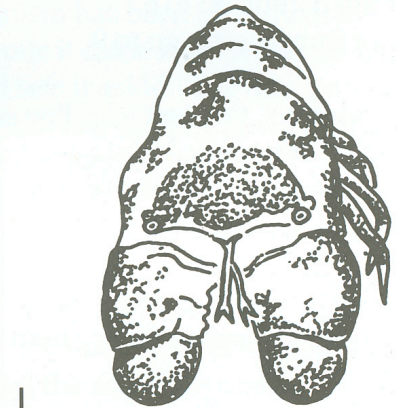
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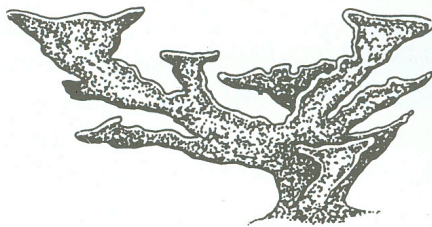
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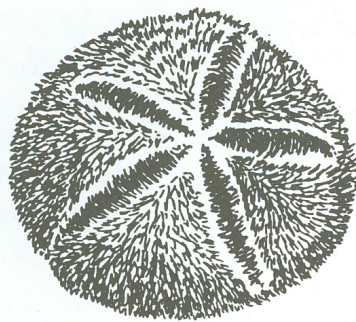
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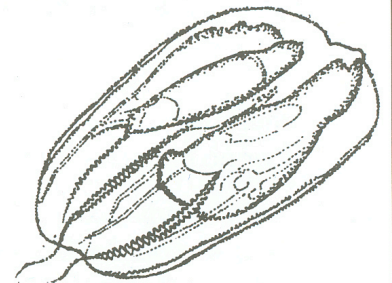
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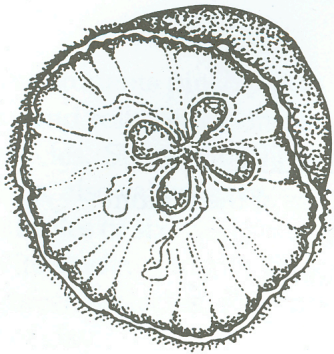
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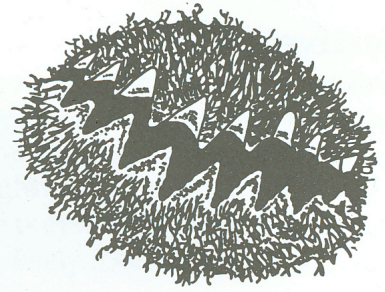
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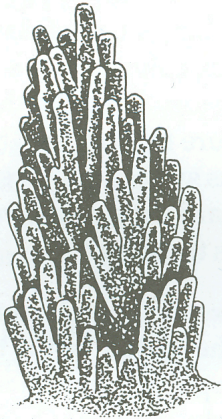
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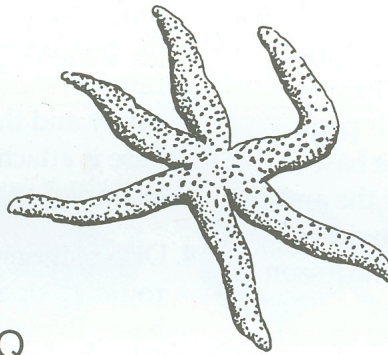
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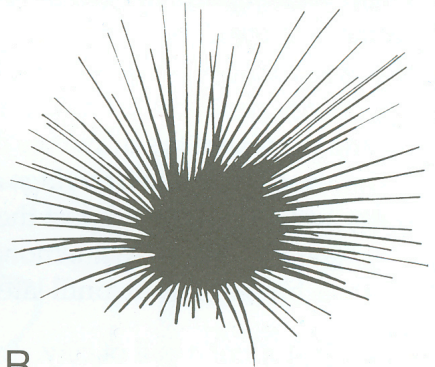
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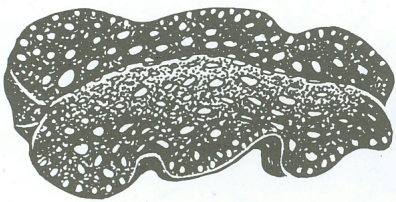
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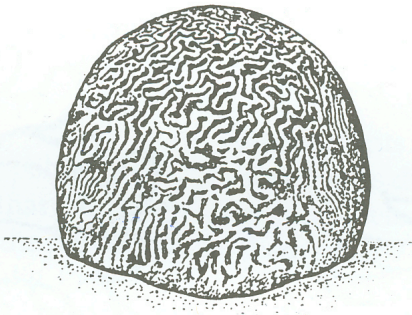
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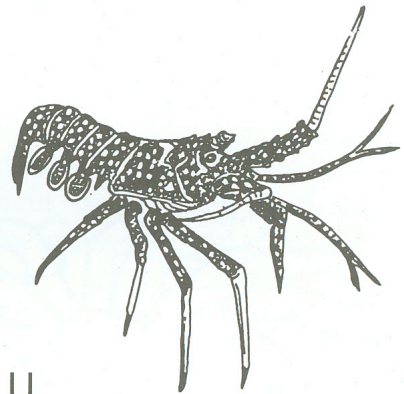
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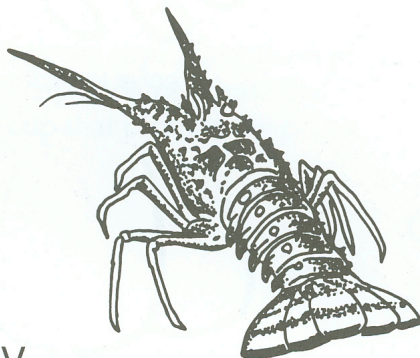
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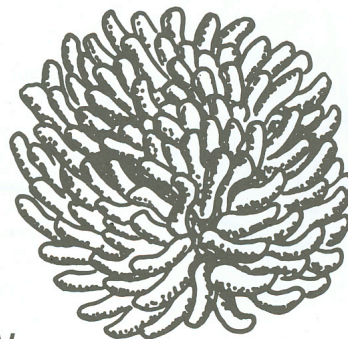
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W

# Create a Coral Polyp

## Objective:

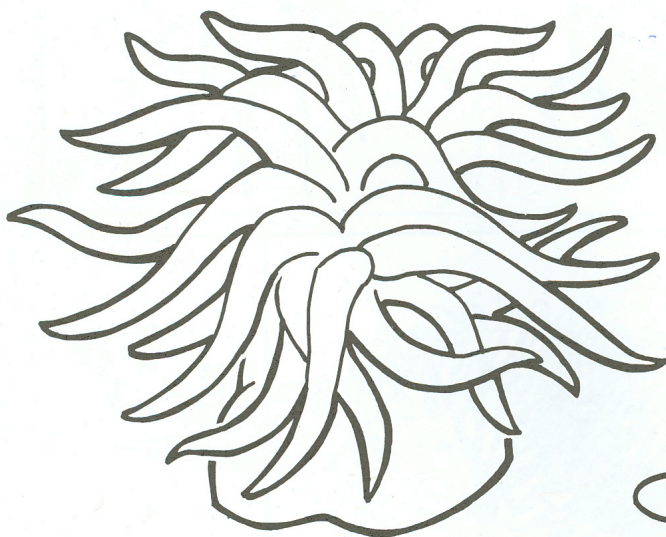
Students will explore the structure, colonial lifestyle, and feeding strategy of a reef-building coral.

## Materials:

modeling clay  
paper cups—one per student  
one copy of the drawings at the bottom of this page (optional)  
popsicle sticks (optional)

## Action:

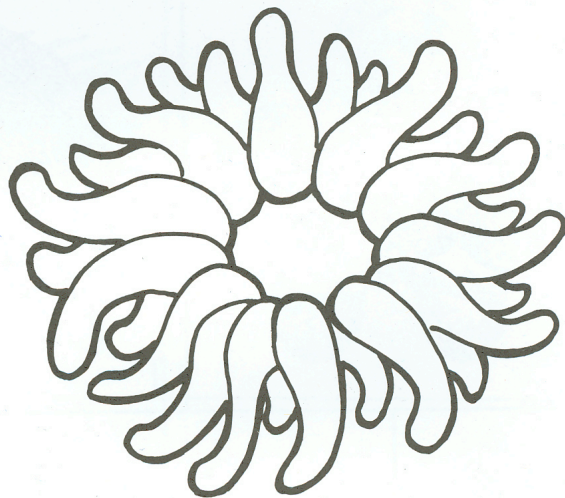
1. To help your students visualize what they'll be creating, use the drawings at the bottom of this page as a guide and draw each part of the coral polyp as you describe it. Or, use a photocopy machine to enlarge the drawings on this page. Cut out the coral polyp drawings of the base, mouth, and tentacles, and post them at the appropriate time. Keep the sea anemone drawing in one piece, but set it aside until later in the lesson.
2. Give each student a ball of clay. Instruct them to divide it into two balls (approximately  $\frac{2}{3}$  and  $\frac{1}{3}$  pieces). Explain that they'll be building a coral polyp as you describe it.
3. Have students use the larger ball of clay to make the polyp's *base*, a thick column that is wider at the bottom than at the top. Describe the base as a tubular, saclike structure that houses the stomach cavity and the nervous system. In most corals, the base is attached to a hard substrate (a rock, for example) and remains there for life.
4. Direct students to make the polyp's mouth—a rounded opening in the middle of the top of the base. Explain that the polyp's mouth not only takes food into the body, it's also where wastes are excreted.



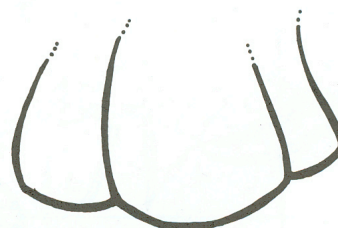
sea anemone



polyp mouth



polyp tentacles



polyp base



5. Have students pinch pieces off the smaller ball of clay and roll them to make the coral polyp's tentacles. Share with them that reef-building corals, also called stony corals, have tentacles in multiples of six. Soft corals have eight tentacles. Invite students to give their polyp six, twelve, or eighteen tentacles. Remind them to save a little bit of clay.

6. While students are adding tentacles, explain that coral polyps come in a range of colors such as white, red, orange, yellow, green, blue, and purple. A type of algae called zooxanthellae that lives in the tissues of reef-building corals gives the polyp a green, brown, or orange color.

7. Draw or post a picture of a sea anemone on the board. Invite students to help you identify the similarities and differences between the two animals (body shape, tentacles, mouth).

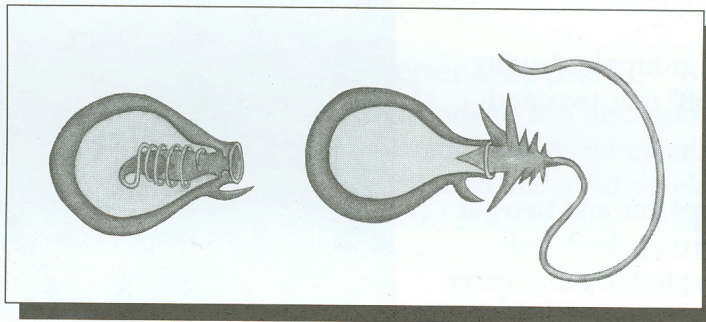
8. Have every five students join their polyps together to make a colony. Explain that this is how reef-building corals grow. When the polyps on the outer layer of a coral structure die, their skeletons remain. The next generation attaches to this hard surface. Coral reefs are a result of layer upon layer of successive generations of a single species of coral.

9. Give each student a paper cup. Have them place their polyp into the cup to demonstrate the calcium carbonate cup that protects the polyp.

Have each student make a slot in his/her cup and insert a popsicle stick, then have them gently push and pull the stick to demonstrate how a coral polyp withdraws into its cup during the day and comes out at night to feed. Describe the way the cup protects the polyp: when the polyp contracts, it's almost completely inside the skeletal cup.

10. How do corals feed? Have students demonstrate feeding by acting as if their fingertip is a small fish swimming toward the coral polyp. Describe how the polyp stuns the fish with its nematocyst (stinging cell), then grabs and moves it to its

mouth with its tentacles. Students can mold prey items with any leftover clay and attach them to their polyp's tentacles or place them in its mouth.



Corals use nematocysts to catch prey. A nematocyst contains a venom-filled barbed thread which is ejected when the capsule is stimulated.

### Deeper Depths:

Divide the class into groups of four to

five students and have them research what colors and shapes different species of corals are. Ask each group to select one species of coral to recreate. Have them use the correct colors of modeling clay to create their polyps (remind them to study pictures or text in books to find out how many tentacles their species has). When they have made a number of small polyps, have them create a cup for each polyp by wrapping a strip of construction paper around the base. Or, use cut-up egg cartons (one polyp per cup). Have students glue or staple the cups together to make the formation their coral species develops.

# No Place to Hide

## Objective:

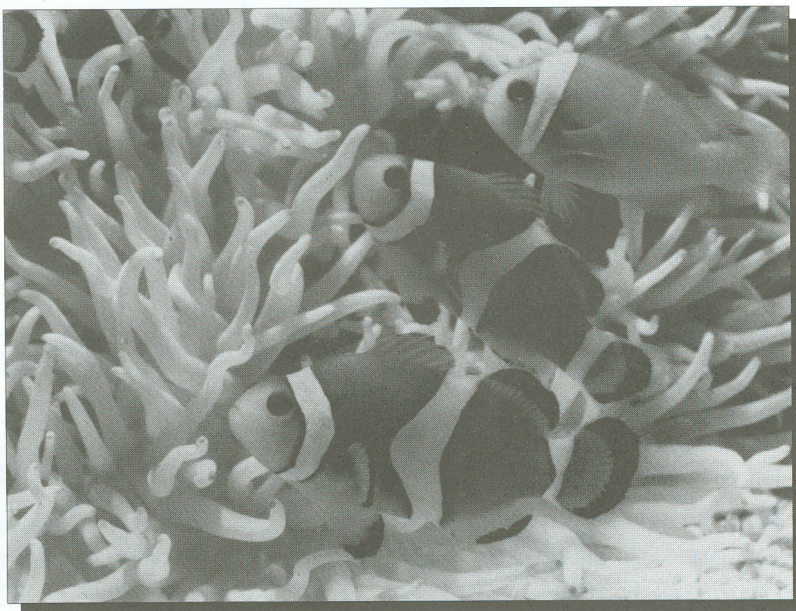
Students will learn how destruction of a coral reef affects the animals that live there.

## Materials:

Large playing area  
copies of page 11 enlarged 200%, cut into individual cards  
yarn or string

## Action:

1. Cut out pictures of reef creatures and attach yarn or string to make a sign that can be placed around a student's neck. You'll need one sign for each student.
2. Divide class into three groups by having individuals "number off" one, two, and three.
3. Have students in groups one and two get together and find a partner. Each pair should find a place to stand in the playing area. Have the partners face each other and join hands over their heads. They represent the coral reef.
4. Students in group three are the reef creatures. Give each student a picture of a reef creature to place around their neck (set extra signs aside). Ask them to demonstrate how that reef creature moves (for example snails move slowly, crabs scuttle sideways, fishes move their tails back and forth to swim). Have them find a "reef" to hide in. Reef creatures stand between two students who are the reef. Only one reef-creature student can hide with one reef pair.
5. Each time the teacher calls out "find a new home," reef creatures must leave their hiding place and find a new one. Any reef creature without a hiding place can't survive, and must leave the game.



The clownfish has a symbiotic relationship with a sea anemone.

6. After a few switches, you should comment on the abundant places the reef creatures have to hide, and ask them if they think it's really like that in the ocean. Tell students that although coral reefs take a long time to develop, they can be destroyed very quickly. Explain that one way coral reefs are destroyed is by careless boaters who drop anchors on the reef and break off parts of it. As you discuss this, physically separate one or two pairs of students who make up a reef, and have them become reef creatures.
7. Resume the game. It will be harder for students to find a reef to hide in, because there are fewer reefs and more reef creatures.



Corals remove and recycle carbon dioxide. Excess amounts of this gas contribute to global warming.

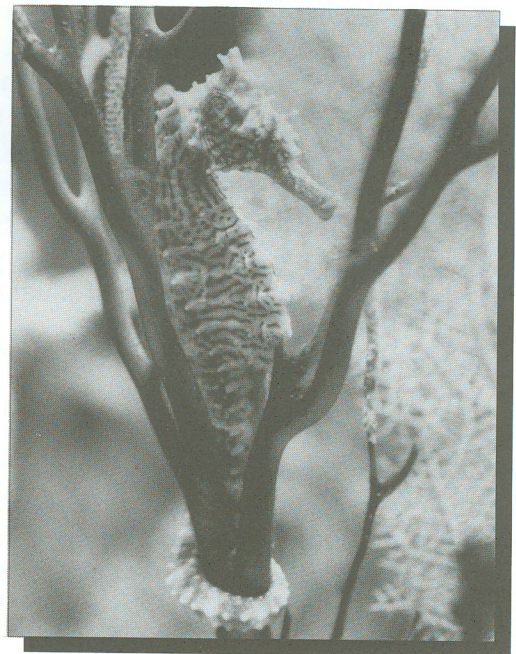
8. After another couple of switches, stop and ask students if they have ever seen tropical fish in an aquarium. Explain that many people buy fish from special fish breeders, but that some of the tropical fish sold in pet stores have been taken directly from coral reefs. The people who collect the fish often use dynamite or poisons to stun the fish and make them easier to catch. Explain that dynamite breaks the reef, while poison kills coral polyps and other reef creatures. Separate another couple of reef pairs, and resume the game. Occasionally, stop and share with your students other ways reefs are destroyed:

- When fertilizer and untreated sewage wash into the ocean, microscopic algae in the water grows faster. Too much algae can overwhelm and smother coral polyps.

- Oil spills, garbage, and other forms of ocean pollution poison polyps.
  - When tropical forests are cut down, soil washes down rivers into the sea. Soil that settles on reefs smothers coral polyps and blocks out the sunlight needed for corals to thrive.
  - Sometimes, divers and snorklers sit or stand on and touch reefs to get a better look at the marine life around them. Without knowing it, they may be injuring delicate coral polyps.
9. Continue playing until you have discussed all the ways reefs are destroyed.

### Deeper Depths:

Lead students in a discussion about how reef destruction affects the creatures that live there. It gets hard to find a hiding place, but what else might get hard to find? (*food*) What happens when the whole reef is destroyed?



Sea horses are one of the many species of fish that live in a coral reef.

# Survival Factors

## Objective:

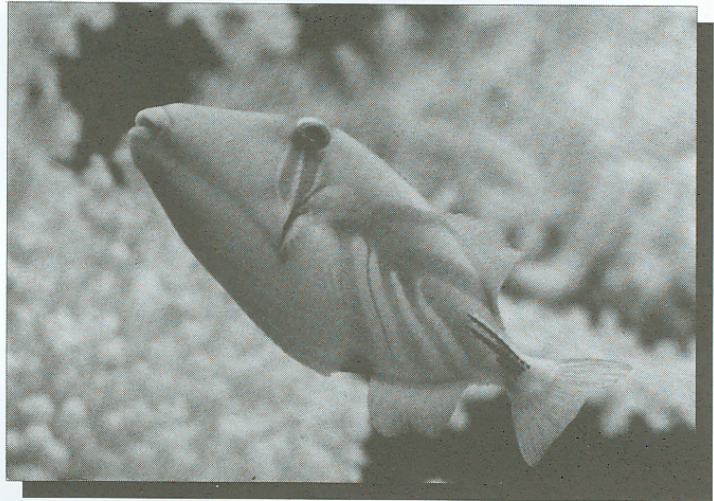
Students will be able to analyze the impact of humans on the coral reef ecosystem as a result of human social, political, and economic activities.

## Materials:

copies of Survival Factor cards on page 21  
copies of Identity cards on page 22 enlarged 200%  
small construction paper squares (five per student)  
yarn

## Action:

1. Copy and cut Survival Factor cards and Identity cards. Attach yarn to Identify cards so students can wear them around their necks.
2. Have students stand in a circle. Pass out Identity cards. Each student now represents a life-form found in a coral reef ecosystem.
3. Give each student five paper squares. Explain that each square represents a population of organisms, which is all the organisms found in a specific area.
4. Tell students that you're going to read some statements that describe events that take place everyday that might or might not affect the reef and its inhabitants. Explain that if they think the statement you read would make it difficult or impossible for their organism to survive, they must put one of their paper squares on the floor in front of them. When students have one square left, they must stand on one foot. When they lose their balance and fall, they must sit down—this species is no longer found on the reef. They also must sit down when they run out of squares.
5. Continue to play until everyone is sitting.
6. Discuss the game with students. Tell them that their species became endangered when they became few in number, as represented by the one paper square. Explain that endangered refers to a population that is in danger of extinction, or disappearing completely. Was it easy for the



The painted triggerfish is found in Hawaiian coral reefs.

students to stay in the game when they reached the point of standing on one foot? When a species becomes endangered, they're on shaky survival ground.

## Deeper Depths:

Have students compare and contrast other habitats (old growth forest, wetlands, desert) and their survival factors. What survival factors are the same for each habitat? Different? How can each one of us make a difference in protecting the balance in each type of habitat?

# Survival Factors

<p>Recreational boaters drop anchors on you.</p>	<p>A tourist takes you from the reef to carry home as a souvenir.</p>
<p>An oil tanker spills thousands of gallons of oil into the water over you.</p>	<p>You swallow some abandoned fishing line.</p>
<p>Agricultural fertilizers have washed into the sea, so now there is a lot more algae in the water around you.</p>	<p>To make money from the tropical fish trade, collectors use dynamite and cyanide, a poison, to stun and capture you and your relatives.</p>
<p>You become tangled in a drift net.</p>	<p>Large pieces of your skeleton are broken off and sold for use in home aquariums.</p>
<p>Ocean pollution from pesticides, heavy metals, and garbage is surrounding you.</p>	<p>The water temperature surrounding the reef mysteriously rises, causing you to expel your zooxanthellae.</p>
<p>A snorkler sits on you and pokes around to get a better look at marine life.</p>	<p>A tropical forest is cleared, washing topsoil down river and into the ocean in the vicinity of your home, a large reef ecosystem.</p>
<p>A scuba diver takes more than the legal limit of your species.</p>	<p>Coastal development destroys the beach you breed on.</p>
<p>Human population growth increases.</p>	<p>Humans think you're delicious, and actively hunt you.</p>

# Identity Cards

pillar coral	zebra moray eel	monk seal
hawskbill sea turtle	queen conch (snail)	painted triggerfish
green sea turtle	four-eyed butterflyfish	trumpet triton (snail)
lined sea horse	king crab	brain coral
barracuda	striped shrimp	elkhorn coral
star-eyed hermit crab	sharpnose pufferfish	emperor angelfish
cowfish	sea urchin	sea anemone
anemone fish	blue-barred parrotfish	stony coral
little star coral	slipper lobster	sea star
branching coral	reef octopus	moorish idol (fish)

# Reef and Write

## Objective:

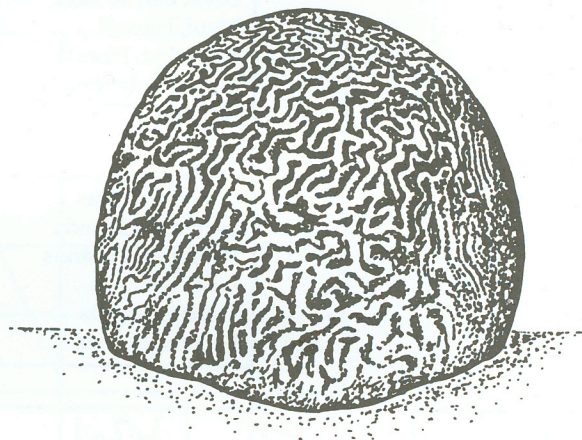
Students will use creative writing to express what they know about corals and coral reef habitats.

## Materials:

paper  
pencils

## Action:

1. Ask students to write about one of the following topics. Encourage them to use whatever form of writing they feel comfortable with—essay, story, poetry, etc.
2. Have students share their finished piece out loud with the class, and/or compile a notebook of their creative writing that is available for students to read when finished with other work.
3. Have students edit and revise their pieces. Encourage students to read and react to their classmates' work.



Corals, such as this brain coral, generally feed at night.

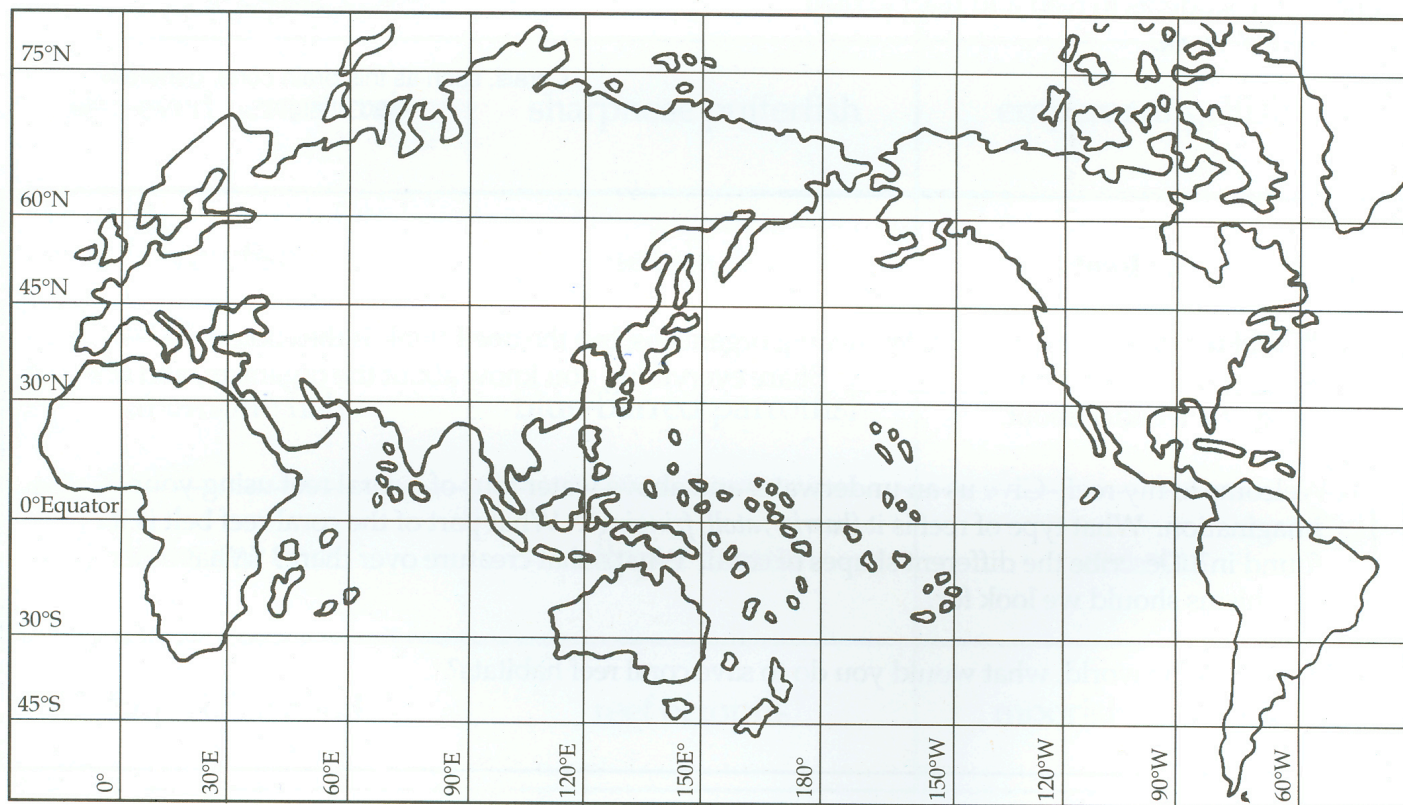
## Writing About Reefs

- A. "Coral reefs are home to many fascinating organisms, but the one I think is the coolest is \_\_\_\_\_, because \_\_\_\_\_." Share everything you know about the organism, and one thing you wonder about.
- B. Welcome to my reef! Give us an underwater and above water tour of a coral reef using your imagination. What type of reef is it (*barrier, atoll, fringing*)? What part of the coral reef belt is it found in? Describe the different shapes of coral. What's that creature over there? What other organisms should we look for?
- C. If you ran the world, what would you do to save coral reef habitats?

# The Reef Region

Use the latitudes and longitudes in the table below to mark the location of these coral reefs. Study the finished map and identify the area of the world where most reef-building corals grow. Use colored pencils or crayons to color in the "reef belt." Between what latitudes is the reef belt?

Location	Latitude	Longitude
Great Barrier Reef	19° 10' S	149° E
Maui, Hawaii	20° 45' N	156° 20' W
Key West, Florida	24° 33' N	81° 48' W
French Polynesia	16° S	145° W
Red Sea	25° N	38° W
Jamaica	18° 15' N	77° 30' W
Belize	17° 15' N	88° 45' W
Cabo San Lucas	23° N	110° W
Seychelles Islands	8° S	55° E
Philippines Islands	13° N	122° E
Java	7° 20' S	110° E
Celebes Islands	2° S	121° 10' E
Bahama Islands	24° 15' N	76° W



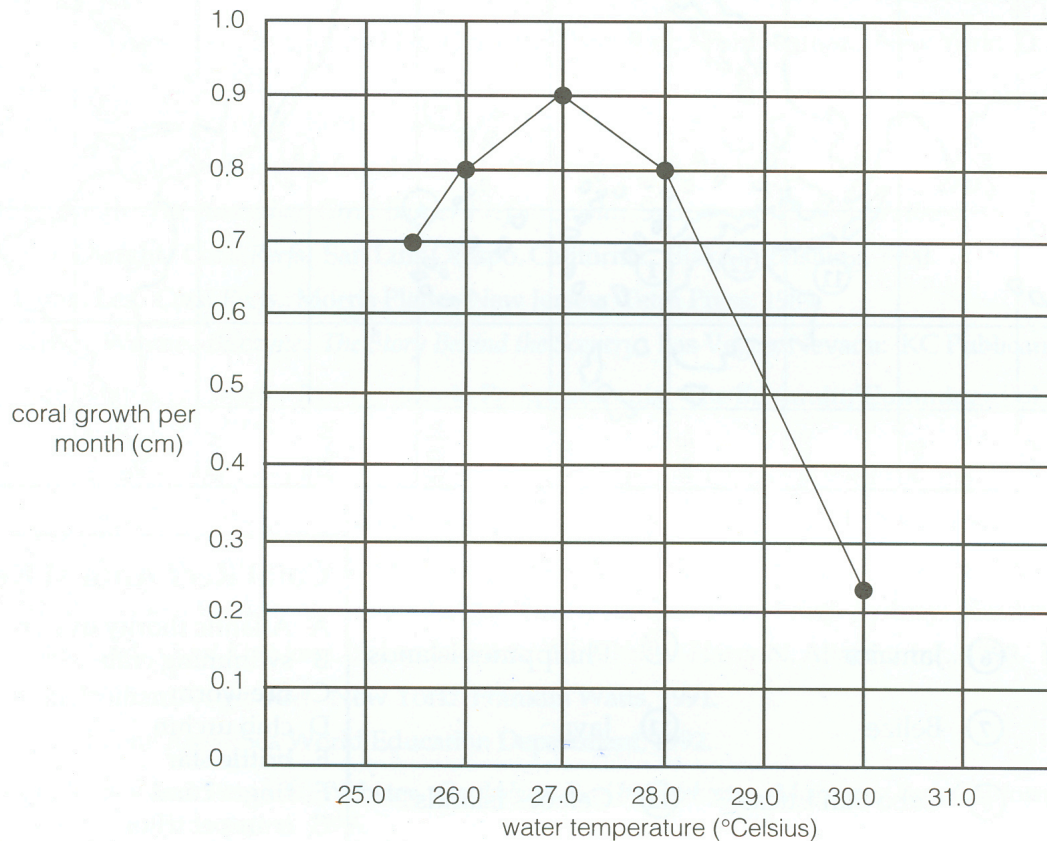
Coral distribution map

**Deeper Depths:** Ask students to research what other habitats besides coral reefs are found in the reef belt.



# How Water Temperature Affects Coral Reef Growth

Reef-building corals require clear, warm water to thrive. By studying the temperature and growth data graphed below, you can discover what the optimum water temperature is for the staghorn coral *Acropora pulchra*, a type of upright, branching coral which is one of the fastest growing kinds of corals.

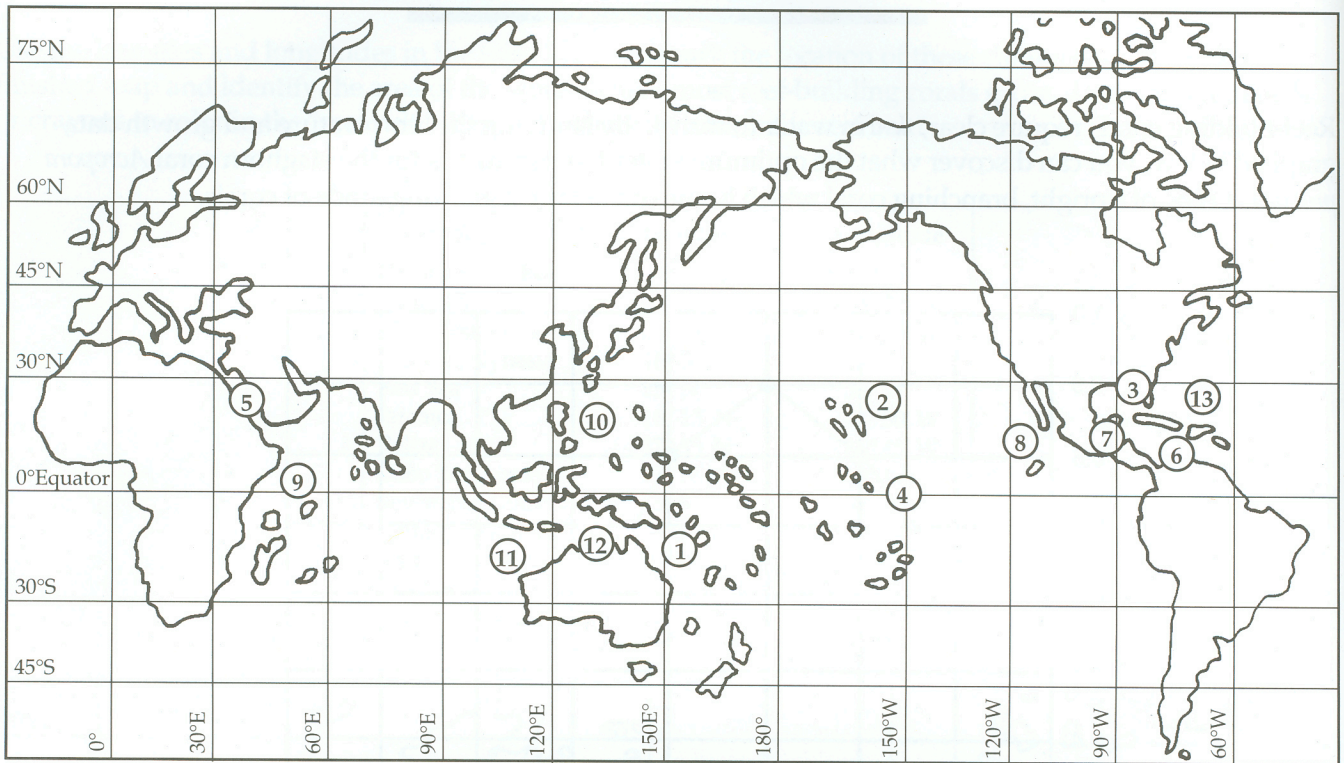


Data from Yap & Gomez (1981)

**Interpret the graph above to answer these questions:**

1. What was the fastest growth rate (in centimeters per month)?
2. What was the approximate water temperature when this rapid growth occurs?
3. At what temperature does the water seem to become too warm for coral reef growth?
4. At what water temperature in degrees Fahrenheit does this species of coral grow the fastest? (To change degrees Celsius into degrees Fahrenheit, you must multiply the °C by 1.8 and add 32.)
5. What range in degrees Fahrenheit does growth exceed 0.8 cm/mo?

# Teacher's Answer Sheet



## The Reef Region:

### Location

- |                      |                      |                       |
|----------------------|----------------------|-----------------------|
| ① Great Barrier Reef | ⑥ Jamaica            | ⑩ Philippines Islands |
| ② Maui, Hawaii       | ⑦ Belize             | ⑪ Java                |
| ③ Key West, Florida  | ⑧ Cabo San Lucas     | ⑫ Celebes Islands     |
| ④ French Polynesia   | ⑨ Seychelles Islands | ⑬ Bahama Islands      |
| ⑤ Red Sea            |                      |                       |

## How Water Temperature Affects Coral Reef Growth:

1. 0.9 centimeters per month
2. 27°C
3. more than 30°C
4. 80.6°F
5. 78.8-80.6°F

## Coral Reef Animal Key

- A Atlantic thorny oyster
- B swimming crab
- C fire worm
- D club urchin
- E brittle star
- F finger coral
- G trumpet triton
- H corkscrew anemone
- I Spanish crab
- J elkhorn coral
- K club urchin
- L comb jelly
- M moon jelly
- N soft sea cucumber
- O Frons oyster
- P pillar coral
- Q comet star
- R long-spined urchin
- S polyclad flatworm
- T brain coral
- U rock lobster
- V spiny lobster
- W sun anemone