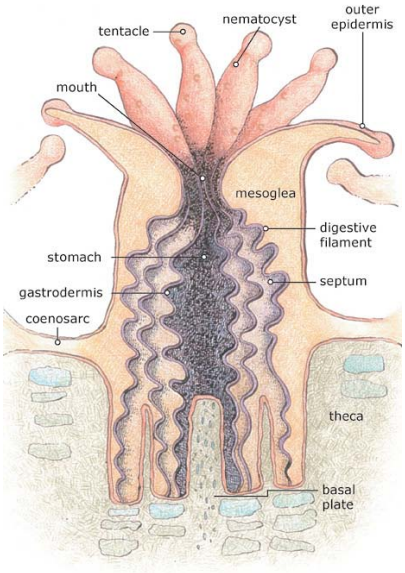
CORAL CORES:
OCEAN TIMELINES

Materials: Coral Coring image, poster size
Poster Adhesive
Metric Rulers (1 per student)
Pencils (1 per student)
Yarn or String
Tape
Date Cards

Background:



Coral polyps are soft-bodied animals related to anemones and jellyfish. Their tube-like bodies are closed at one end, with a mouth opening at the other end, surrounded by flexible, stinging tentacles.

When coral polyps of the same species grow in close proximity to one another, they form a colony, with each polyp joined to the one beside it. Beneath this layer of living tissue, the polyps of reef-building corals create hard "cups" of calcium carbonate. This is what we consider the hard, or stony, part of the reef. This is the coral skeleton.

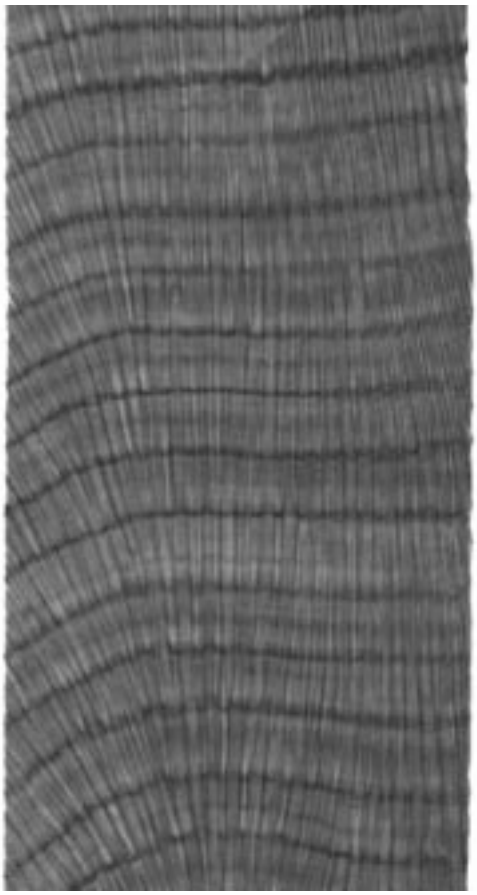
As coral colonies grow, new layers of skeleton are deposited. The amount of growth in coral skeletons is determined by variations in temperature and other weather conditions. In the Gulf of Mexico, scientists have determined that coral skeletons tend to grow more rapidly in the fall and winter months, creating less dense growth, while slower growth rates in summer create higher density skeleton. This variation creates identifiable growth bands in coral colonies, much like those observed in trees.

In order to see these layers, scientists must drill cores out of established coral heads. This gives them a look at years worth of layers in one compact unit. The larger the coral colony, the more years of data they can extract.

X-rays of coral cores allow scientists to examine the annual growth bands in reef-building corals. Dark bands show the slow, high-density growth that takes place during the summer. Lighter bands show the faster, low-density growth that takes place during the winter.

Scientists can take a look back in time to determine when temperatures were warmer or cooler, by simply examining the depth of each growth band. Larger low-density bands indicate warmer winter temperatures. Slightly darker bands, known as stress bands, indicate periods of environmental stress, such as temperature extremes.

Photo: Amy Bratcher



Montastrea faveolata coral core from FGBNMS

Within each band scientists can also evaluate the chemical content to learn more about atmospheric conditions. By drilling out 12 tiny samples from each growth band, they can examine the oxygen and carbon isotopes to determine specific temperatures during each month of the year.

In 2005, coral core samples were taken from several colonies of *Montastrea faveolata*, a species of star coral, in the East and West Flower Garden Banks. Scientists from Texas A&M University are currently analyzing these core samples to identify patterns in growth over periods of time. They will then compare these to what we know of air and water temperature readings in the region at those times. This information can then be used to help them evaluate cores that go back farther than recorded weather data, and allow them to "read" weather history.

So why do we want to do all of this? Understanding how climate change has affected the Gulf of Mexico over a period of years, decades, or even centuries may help us recognize and anticipate future climate changes, so that we can appropriately manage our marine resources.

Procedure:

Part I:

1. Cut apart the four core images, then copy and enlarge them. To create life size images you will have to double the size of each core. Display the core images on the wall, one above the other, to create one continuous core.
2. Have students examine the images and identify the summer growth bands. Remember, these are the denser, darker bands caused by slower growth.
3. Have students identify the winter growth bands. These are the lighter, less dense areas.
4. Starting at the top of the core, have students label the very first dark band as 2005.
5. Have students count back and label every 10 years on the core (i.e. 1995, 1985, 1975, etc.). How many years are represented by this coral core sample?
6. Distribute metric rulers.
7. Have each student select a 10-year span and measure the depth of each growth band within that decade, to the nearest millimeter. What is the greatest depth? Least depth? Average depth? What does this tell them about temperature change in that decade?
8. Have students identify any stress bands within that decade. What kinds of stressors might cause these?
9. Assuming that the coral core is incomplete by about 50 years, have students calculate the likely thickness of the coral head at the start of the core (the oldest part). Reposition the poster so that the bottom of the core sample is that far above the floor. Use yarn or string to extend the outline of a coral head from the bottom of the core to the floor.

10. Using the same assumption as above, have students calculate the likely thickness of the coral head at the time the core sample was taken. Again, extend an outline of a coral head from the top of the core to the floor. Compare the change in size over the lifespan of the coral head.

Part II:

1. Copy and cut apart the Date Cards and lay them face down on a table.
2. Have each student select one of the Date Cards and match it to the corresponding year on the coral core photo, attach the card to the poster, then draw a line to the appropriate growth band.
3. Have each student calculate the approximate thickness of the coral head at the time that event took place.
4. Discuss with students the events and world changes that have occurred during the lifespan of that coral head. Are any of these events likely to have affected the corals of the Flower Garden Banks National Marine Sanctuary?

Notes: The coral core images on the last page of this activity are x-rays of a *Montastrea faveolata* core taken from the Flower Garden Banks National Marine Sanctuary. These images are consecutive, from left to right, and account for the entire core sample.

You will notice there are some breaks in the sample. These occurred while attempting to extract the core from the coral head. This might lead to a discussion on the difficulties of doing this kind of work. Scientists don't always get to work with "perfect" samples.

The small arrows that you see next to the core sample on the far right indicate the location of high-density growth bands from the years 1860, 1850 and 1840. You can use these as reference points to help check your students' work.

OCEAN SCIENCE
DATE CARDS

January 17, 1992 Flower Garden Banks National Marine Sanctuary designated in northwestern Gulf of Mexico.	**January 23, 1960** Bathyscaph *Trieste* made the world's deepest dive to 35, 802 feet in the Marianas Trench.
May 2, 1775 Benjamin Franklin made the first scientific study of the Gulf Stream.	**March 15, 1960** President Eisenhower created the first underwater preserve in the U.S in Key Largo, Florida.
March 23, 2005 An autonomous underwater vehicle was launched near Bermuda to collect scientific data in information the Gulf Stream.	**March 24, 1989** Exxon-Valdez spilled 11 million gallons of oil into Prince William Sound, Alaska, affecting 2000km of Alaska coastline.
April 15, 1912 The *HMS Titanic* sank after striking an iceberg in the north Atlantic.	**April 28, 1962** Thor Heyerdahl and his crew sailed from Peru on a raft called *Kon Tiki*, arriving in Polynesia 101 days later.
June 8, 1992 World Oceans Day was celebrated for the first time.	**August 10, 1846** The Smithsonian Institute was founded.
June 2, 1977 The leatherback sea turtle was listed as endangered throughout its range.	**April 22, 2010** The Deepwater Horizon drilling rig exploded and collapsed into the Gulf of Mexico causing a massive oil spill.
July 16, 1872 Roald Amundsen, polar explorer and first to reach the South Pole, was born.	**June 11, 1910** Jacques Cousteau, ocean explorer and inventor of SCUBA, was born.

February 12, 1809 Charles Darwin, famed naturalist and explorer, was born.	**August 4, 1790** The U.S. Coast Guard was established.
January 3, 1807 Sir James Clark Ross took the first modern sounding in the deep sea.	**October 1996** Stetson Bank was added to the Flower Garden Banks National Marine Sanctuary.
August 15, 1934 William Beebe and Otis Barton descended 3,028 feet under the sea in a bathysphere.	**December 22, 1938** Marjorie Courtenay-Latimer discovered the first living Coelacanth.
September 1, 1985 Dr. Robert Ballard discovered the wreck of the *HMS Titanic.*	**October 18, 1972** The Clean Water Act was enacted.
October 23, 1972 The Marine Protection, Research and Sanctuaries Act established the National Marine Sanctuary Program.	**November 1947** Kerr-McGee drilled the first commercial oil well out of sight of land in the Gulf of Mexico.
November 17, 1869 The Suez Canal opened.	**December 1862** The ironclad ship *Monitor* sank off of Cape Hatteras, NC.
August 28, 1998 An artificial reef was formed off Port Isabel, TX by sinking a ship.	**December 28, 1973** The Endangered Species Act was enacted.

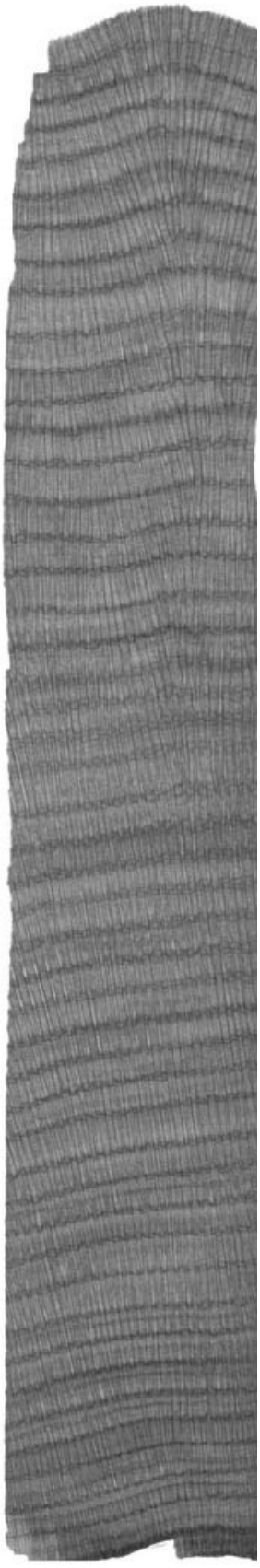
WORLD EVENTS
DATE CARDS

September 16, 1810 Mexico won its independence from Spain.	**June 18, 1812** The War of 1812, between the U.S. and Great Britain, began.
1817-1820 Jean Lafitte occupied Galveston Island and used it as a base for smuggling and privateering.	**January 3, 1823** Stephen F. Austin received a grant from Mexico to begin colonization of Texas.
December 3, 1828 Andrew Jackson was elected President of the United States.	**December 23, 1823** Clement C. Moore first published *A Visit from St. Nicholas*.
June 14, 1834 Isaac Fischer, Jr. received a patent for sandpaper.	**August 27, 1957** The first oil well in the U.S. was drilled near Titusville, PA.
February 23-March 6, 1836 The Mexicans laid siege to the Alamo in Texas.	**May 5, 1862** Mexico wins independence from Spain (Cinco de Mayo).
April 21, 1836 Sam Houston won the Battle of San Jacinto against Mexico.	**December 29, 1845** Texas became the 28th state under President James Polk.
March 17, 1845 The rubberband was invented.	**August 15, 1914** The Panama Canal was opened.

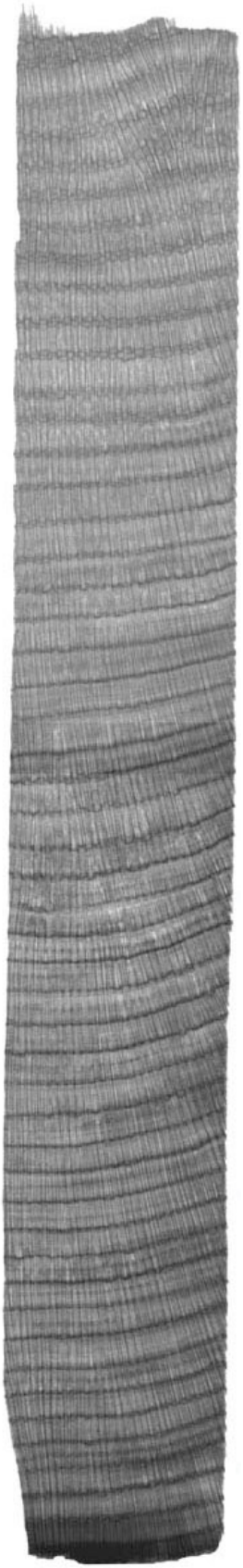
December 29, 1851 The first YMCA opened in Boston, MA.	**May 1, 1840** First postage stamp issued in Great Britain.
October 27, 1997 Mini-crash of stock markets around the world.	**April 9, 1865** The U.S. Civil War ended.
February 1, 1861 Texas joined the Confederate States of America.	**January 1, 1863** Abraham Lincoln signed the Emancipation Proclamation.
March 30, 1870 Texas was re-admitted to the Union.	**March 7, 1876** Alexander Graham Bell received a patent for the telephone.
July 4, 1876 The United States celebrated its Centennial.	**January 27, 1888** The National Geographic Society was founded in Washington, DC.
March 12, 1912 The Girl Scouts organization was founded.	**March 12, 1894** Coca Cola was first sold in bottles.
September 8, 1900 The *Great Storm* struck Galveston and destroyed the island, killing over 6000 people.	**September 18, 1926** The Great Miami Hurricane killed over 100 people.

December 17, 1903 The Wright Brothers made their first flight at Kitty Hawk.	**October 3, 1906** SOS became the international distress signal.
June 25, 1950 The Korean War began.	**1965** U.S. troops were first committed to the Vietnam War.
September 7, 1888 George Eastman patented the first film camera under the trademark *Kodak*.	**January 1, 1892** Ellis Island began accepting immigrants.
September 1, 1939 World War II began.	**October 28, 1986** 100th anniversary of the dedication of the Statue of Liberty in New York Harbor.
1917 The zipper was patented.	**1914** **World War I began.**
1910 The Boy Scouts of America was founded.	**September 15, 1883** The University of Texas opened in Austin, TX.
May 16, 1888 The state capitol was dedicated in Austin, TX.	**January 10, 1901** "Black Gold" was discovered at Spindletop oil field near Beaumont, TX.

Photos: Amy Bratcher

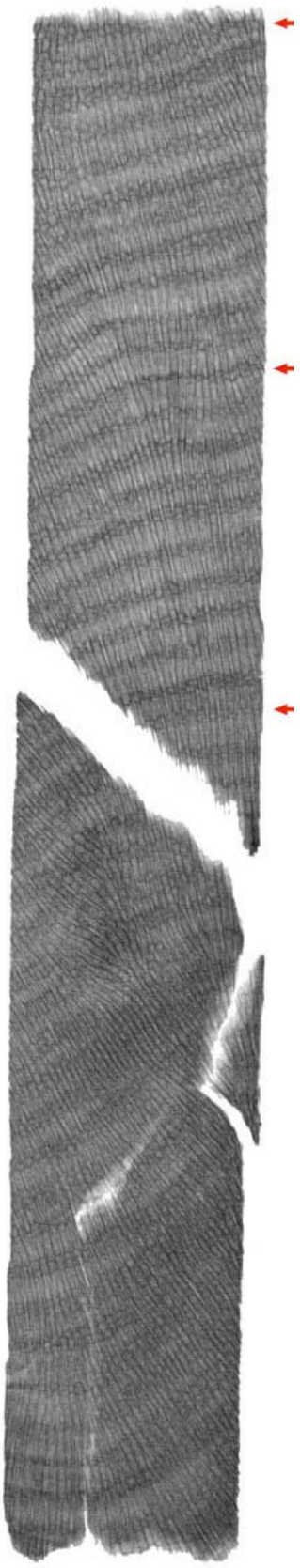


A



B

C



Montastrea faveolata

Flower Garden Banks National Marine Sanctuary
http://flowergarden.noaa.gov

NATIONAL MARINE SANCTUARIES
FLOWER GARDEN BANKS

NATIONAL SCIENCE EDUCATION STANDARDS (NSES)

All Grades

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard E: Science and Technology

- Abilities of technological design
- Understanding about science and technology

Content Standard G: History and Nature of Science

- Science as a human endeavor

Grades 5-8

Content Standard C: Life Science

- Structure and function in living systems

Content Standard G: History and Nature of Science

- Nature of science
- History of science

Grades 9-12

Content Standard C: Life Science

- Behavior of organisms

Content Standard G: History and Nature of Science

- Nature of scientific knowledge
- Historical perspectives

OCEAN LITERACY PRINCIPLES

5. The ocean supports a great diversity of life and ecosystems.
(f) Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate, and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

CLIMATE LITERACY PRINCIPLES

3. Life on Earth depends on, is shaped by, and affects climate.
(a) Individual organisms survive within specific ranges of temperature, precipitation, humidity, and sunlight. Organisms exposed to climate conditions outside their normal range must adapt or migrate, or they will perish.
(c) Changes in climate conditions can affect the health and function of ecosystems and the survival of entire species.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS (TEKS)

Grade 5
(2c) Collect information by detailed observations and accurate measuring.
(2d) Analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence.
(9a) Observe the way organisms live and survive in their ecosystem by interacting with the living and non-living elements.

Grade 6
(2e) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
(12e) Describe biotic and abiotic parts of an ecosystem in which organisms interact.

Grade 7
(2e) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
(13a) Investigate how organisms respond to external stimuli found in the environment.

Grade 8
(2e) Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends. (
(11b) Investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperature, or soil composition.
(11c) Explore how short- and long-term environmental changes affect organisms and traits in subsequent populations.

Aquatic Science
(5a) Evaluate data over a period of time from an established aquatic environment documenting seasonal changes and the behavior of organisms.
(6b) Examine the interrelationships between aquatic systems and climate and weather, including El Niño and La Niña, currents, and hurricanes.

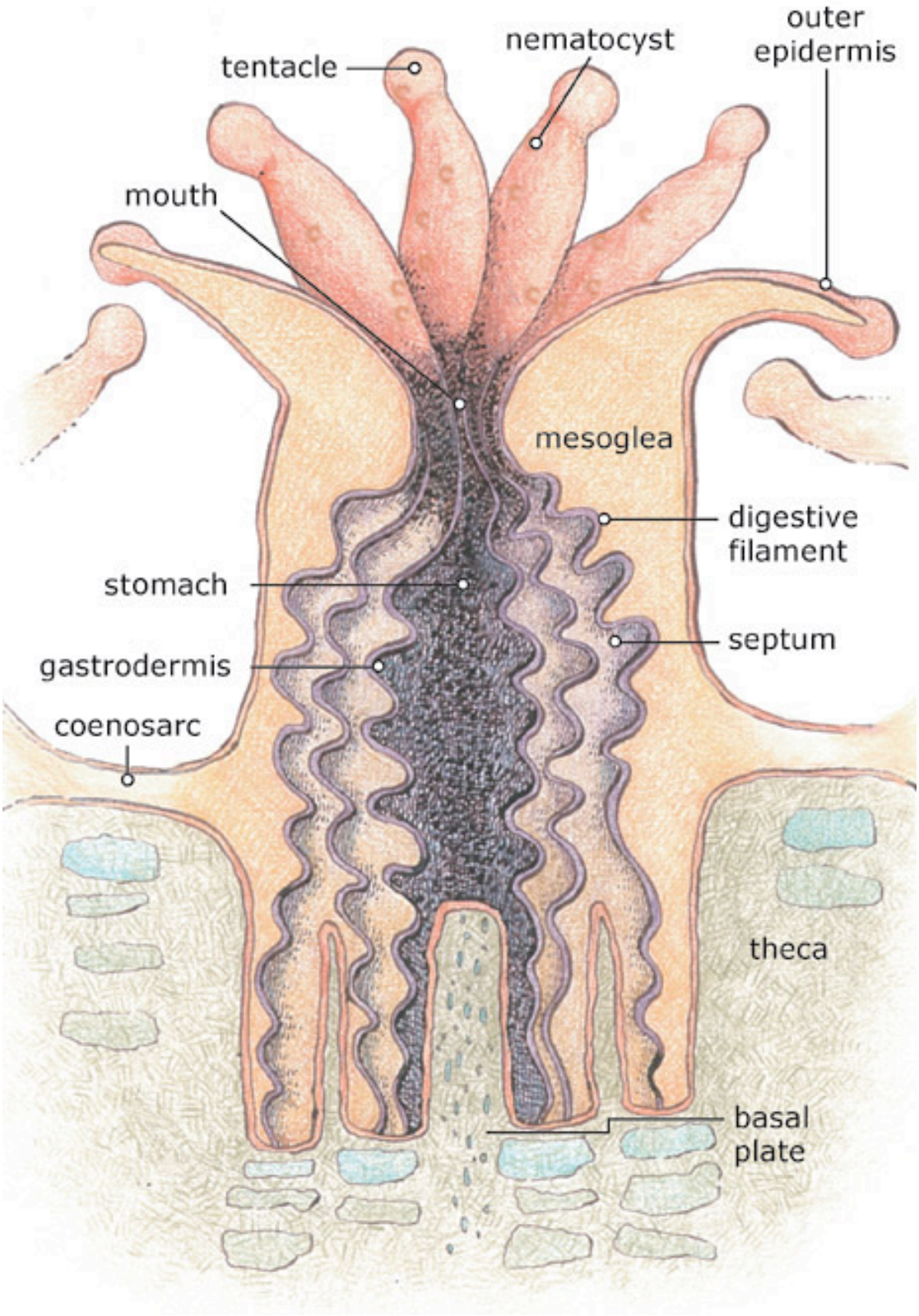
Biology
(11b) Investigate and analyze how organisms, populations, and communities respond to external factors.

Earth and Space Science
(15e) analyze recent global ocean temperature data to predict the consequences of changing ocean temperature on evaporation, sea level, algal growth, coral bleaching, hurricane intensity, and biodiversity.

Environmental Systems
(4d) Make observations and compile data about fluctuations in abiotic cycles and evaluate the effects of abiotic factors on local ecosystems and local biomes.
(8a) Analyze and describe the effects on areas impacted by natural events.

ANATOMY OF A CORAL POLYP

from NOAA Ocean Service Education



ANATOMY OF A CORAL POLYP:

Most reef-building corals are made up of hundreds of thousands of individual polyps like this one. These polyps generally range in size from one to three millimeters in diameter.

Anatomically, a polyp is a very simple organism. Much of its body consists of a stomach filled with digestive filaments. The polyp takes in food and expels waste through its mouth, the only opening.

A ring of tentacles surrounding the mouth aids in capturing food, expelling waste and clearing away debris. Most food is captured with the help of special stinging cells called nematocysts, which are inside the polyp's outer tissue, called the epidermis.

Calcium carbonate is secreted by reef-building polyps and forms a protective cup called a calyx within which the polyp sits. The base of the calyx upon which the polyp sits is called the basal plate. The walls surrounding the calyx are called the theca.

The coenosarc is a thin band of living tissue that connects individual polyps within a colony to one another.

To learn more about corals, visit NOAA Ocean Service Education on the web at:
http://www.oceanservice.noaa.gov/education/kits/corals/welcome.html

This information page is brought to you by:

NOAA Flower Garden Banks National Marine Sanctuary
http://flowergarden.noaa.gov

National Marine Sanctuaries
Flower Garden Banks

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

CORAL SPAWNING GLOBE

Supplies (Makes 10-24 globes):

- 20-24 plastic jars (8-10 oz.) with screw on lids (size may vary) – wide mouth works best
- Modeling clay – oil based
- Water color paintbrushes with narrow handles (or other blunt ended tools)
- 24 bump chenille stems
- Scissors or wire cutters
- Large mixing container (8 quart size or larger)
- 24 cups water
- 8 tsp. (4 packets) *Knox Original Gelatine* (unflavored) – using another brand may produce different results
- Spoon
- Blue food coloring
- 20-24 Tbsp. plastic stuffing pellets
- Teflon tape (used by plumbers)

Background:

Every year, beginning about 7-10 days after the full moon in August, the corals at the Flower Garden Banks National Marine Sanctuary have a mass spawning event. Each night, corals release their sperm and egg packets into the water en masse. Only one species will spawn on any given night. This prevents fertilization between species (which would result in sterile offspring). The egg packets and sperm float to the surface, where the egg packets burst open, releasing millions of eggs to be fertilized. As the planula (baby corals) develop over the next few weeks, they gradually become heavy enough to sink and settle on the bottom. Those that are fortunate enough to land in an area with the proper conditions will mature into coral polyps (individual animals) that will reproduce by splitting and/or budding, thus forming a coral colony. Optimal growing conditions for reef building stony corals include:

- *A hard surface to anchor the polyp against currents and waves*
- *Warm water (68-85 degrees Fahrenheit)*
- *Clear, sunlit water for the symbiotic zooxanthellae (algae) that lives in the coral's tissue and produces the primary food source for the host coral*
- *Moving water, to provide a constant supply of microscopic plankton as a secondary food source.*

Procedure:

1. Use various colors of modeling clay to create a small reef of boulder corals and sponges that will fit inside each jar lid.
2. Place a reef on the inside of each jar lid, pressing firmly around the outer edges to make it adhere firmly to the lid.
3. Use the handle end of the paintbrush to poke shallow holes into the "corals" to represent the individual coral cups that make up a whole coral colony.
4. Cut each chenille stem apart between each of the fluffy segments.
5. Fold each chenille segment in half and press the folded ends into the "reef" at various intervals to represent Christmas tree worms (about 3-4 per reef).
6. Sprinkle gelatin over 6 cups of cool water in mixing container.
7. Bring remaining 18 cups of water to a boil, and then add it to the contents of the mixing bowl.
8. Stir mixture until gelatin is thoroughly dissolved, then allow it to cool completely.
9. Add a few drops of blue food coloring and stir until color is uniform.
10. Fill individual jars with blue mixture, leaving room for displacement by coral colony.
11. Add 1 Tbsp. of plastic pellets to each jar. These represent the sperm and egg packets released by corals during sexual reproduction.
12. Screw the lid onto each jar, with the reef attached. The reef will now be hanging upside down.
13. Check the liquid level in each jar. Remove or add liquid as necessary to make sure each jar is full.
14. Place a single layer of Teflon tape around the top edge of the jar, covering the screw threads, before screwing the lid onto the jar for the final time, to prevent leakage.
15. Shake up the jars and turn them upside down so that the lids are resting on the table. The plastic pellets should rise from the "reef" to what is now the top of the jar, resembling a mass spawning event at the Flower Garden Banks National Marine Sanctuary.