



Lesson 1: Growing Up Coral

Theme: Coral Reef Biology

Grade Levels: 6-8

Duration: 60 minutes

Students will learn about the different stages of coral development through an interactive game.

Next Generation Sunshine State Standards:

LAFS.6.SL.1.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on grade six topics, texts and issues, building on others' ideas and expressing their own clearly.

SC.7.E.6.6 Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.

SC.7.L.16.3 Compare and contrast the general processes of sexual reproduction requiring meiosis and asexual reproduction requiring mitosis.

SC.8.N.4.2 Explain how political, social and economic concerns can affect science, and vice versa.

OBJECTIVES

- Observe the different stages of coral development.
- Identify different environmental and human threats that affect coral reproduction and survival.
- Understand the importance of synchronous spawning in corals.
- Describe how corals reproduce sexually and asexually.

MATERIALS

- Six dice (one for each station).
- Printed instructions for each station (pages 6 to 11).
- Laminated icons of each stage of development for each student (page 12).



VOCABULARY

CORAL POLYP:	a singular polyp is a sedentary, soft-bodied animal that secretes a calcium carbonate - or limestone - skeleton
CORAL COLONY:	a collection of genetically identical and interconnected coral polyps
BUDDING:	type of asexual reproduction in which a new polyp grows out of an existing polyp
SPAWNING:	eggs are released into the water column to be fertilized
MASS SPAWNING:	simultaneous, synchronized spawning of different species
BROODING:	sperm fertilize eggs inside the coral; the fertilized bundles, or zygotes, are released into the water column as relatively developed coral larvae ready for settlement
GAMETE:	a mature sexual reproductive cell, either sperm or egg
ZYGOTE:	fused sperm and egg cells that form a single, fertilized ovum
EMBRYO:	unborn or unhatched offspring in the process of development
PLANULA:	a free-swimming larva
PLANKTON:	microscopic organisms drifting and swimming in the ocean; plankton can be plants, animals or other organisms
METAMORPHOSIS:	in corals, it represents a change from a moving larva to a sedentary polyp attached to the reef
CLIMATE CHANGE:	the change in global climate patterns, attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

Ocean Literacy Principles:

5. The ocean supports a great diversity of life and ecosystems.

Climate Literacy Principles:

3. Life on Earth depends on, is shaped by and affects climate.

Background Information:

Florida's Coral Reef

Florida's Coral Reef is the only barrier coral reef system in the continental United States. Of the 43+ stony coral species on Florida's Coral Reef, seven are listed as threatened under the Endangered Species Act. Coral reefs are among the most biodiverse ecosystems on the planet, providing habitat for 25% of all marine life.

Coral polyps are tiny, soft-bodied animals that build calcium carbonate - or limestone - skeletons. Imagine an upside-down jellyfish tucked into a limestone cup - this is what most coral polyps look like. Corals and jellyfish are related, and both use stinging cells to catch prey. The large and colorful corals we picture in our heads are coral colonies, a collection of genetically identical and interconnected coral polyps. Coral colonies can be different shapes, sizes and colors. When coral polyps die, they leave behind their hard, stony, branching structure. This contributes to the overall structure of the coral reef.

Coral Reproduction

Corals reproduce both sexually and asexually. The two main types of asexual reproduction are fragmentation and budding. Fragmentation occurs when a piece of the coral breaks off and lands in a spot favorable for it to settle and continue growing. This is similar to how sea stars can rejuvenate their arms when they are cut! Coral colonies also grow by budding when a coral polyp divides into two polyps. Corals can grow approximately 1 to 10 centimeters per year through budding, depending on the species.

Sexual reproduction happens in two ways: through brooding or spawning. Brooders fertilize the egg and sperm internally and release both as bundles.

During specific times of the year, the coral polyps will release their larvae, which are usually larger than spawned larvae and ready for settlement. These baby corals already have their zooxanthellae, the tiny symbiotic algae that provide the coral with food and nutrients.

Unlike brooders, spawning corals release egg and sperm separately into the water column for external fertilization. This release must be synchronized for the gametes to have their best chance at fertilization. Corals have special cues for spawning at just the right time. They wait for changes in sea surface temperature and daylight to signal that it is summer. They use the lunar cycle to spawn a few nights after the full moon. Regional winds need to be relatively calm. During mass spawning, different species simultaneously release their gametes into the water. Following spawning, the released gametes will fuse together to form a zygote. As the zygote undergoes cell division, it will form an embryo and eventually a planula. A planula is a coral larva that can swim until it finds suitable hard surface to settle on. The motile planula transitions into a sedentary polyp after undergoing metamorphosis. Polyps secrete skeletons of calcium carbonate (CaCO₃) - or limestone - that over time build the reef.

As we will see during the activity, corals face a variety of local and global stressors ranging from land-based sources of pollution to climate change that make it challenging to reproduce successfully.

Lesson Preparation

Prepare six stations for the Growing Up Coral game by placing one die and one life stage sheet at each station with the laminated icons and instructions page.

Each student should receive one life stage icon to begin the Growing Up Coral game. Divide the six life stages evenly among your students. For example, if you have 30 students, five students should start out as a mature coral, five should start out as zygotes, and so on. Pass out one life stage icon to each student and place the remaining icons at their matching station for students to collect during the game.

Lesson Procedure

Introduce your students to Florida's Coral Reef using the Lesson #1 PowerPoint. The PowerPoint will eventually instruct you to show your students these two videos:

- [Corals: The Birds and the Bees Reef Reproduction video](#) by Khaled bin Sultan Living Oceans Foundation.¹
- [The Amazing Coral Lifecycle - From Dusk till Spawn](#).²

Describe the Florida coral species that either spawn or brood, referring to the PowerPoint images.

Game: Growing Up Coral

The objective of the game is to go through all six life stages of a coral:

- Mature Coral.
- Spawning – Gametes.
- Zygote.
- Embryo.
- Planula.
- Young Polyp.

1. Each student will be given a life stage icon. This determines which station the student will report to once the game begins.
2. Corals reproduce by mass spawning, which means that corals on the same reef need to spawn simultaneously. Students represent corals, so to start the game, two class representatives must roll the same number on the dice at the same time. Once the two class representatives roll the same number, the game officially begins.
3. Students report to their stations:
 - Station 1: Mature Coral.
 - Station 2: Spawning – Gametes.
 - Station 3: Zygote.
 - Station 4: Embryo.
 - Station 5: Planula.
 - Station 6: Young Polyp.
4. After arriving at a station, students take turns rolling the die. The number you roll tells you what happens to you at this stage. Roll the die, learn what happens to your coral at this stage, and keep rolling until you roll a 6, which allows you to move to the next stage of development.
5. Before leaving each station, collect the icon that represents it.
6. Students must visit all stations and collect all icons to finish the game.

Class Discussion

Lead a class discussion on coral reproduction and the various threats that affect each stage of development. Suggested topics:

- What are the benefits of mass spawning?
- Corals undergo metamorphosis. What are the different stages that they go through?
- What are natural challenges that corals encounter in the early stages of development?
- How do human activities affect the development of corals?
- Climate change is the greatest threat to the coral reef ecosystems. What are some effects of climate change that are detrimental to a reef?

Extension

Watch How do you get coral to spawn? Learning about Project Coral at the Horniman Museum and Gardens (4:26 minutes) to learn how innovative techniques are used to induce coral spawning in a lab setting in London.³

Similar techniques are being used by the Florida Aquarium to induce spawning of the endangered Atlantic pillar corals. Watch them spawn in slow motion during Project Coral: A Scientific Breakthrough (1 minute).⁴

Sources

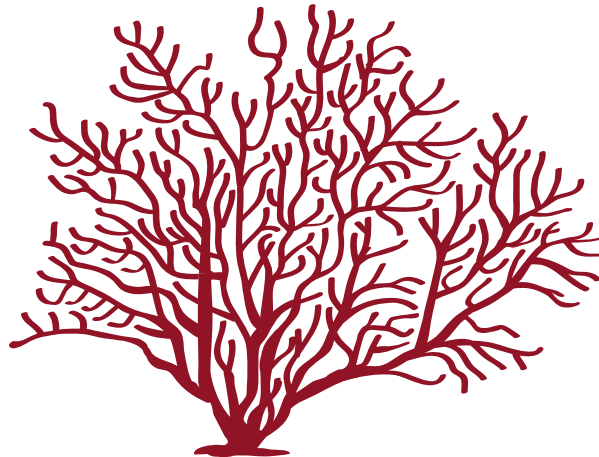
- Threats to coral reefs.⁵
- Coral life cycle.⁶

GROWING UP CORAL: CORAL REEF REPRODUCTION GAME

PHASE 1 – MATURE CORAL

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

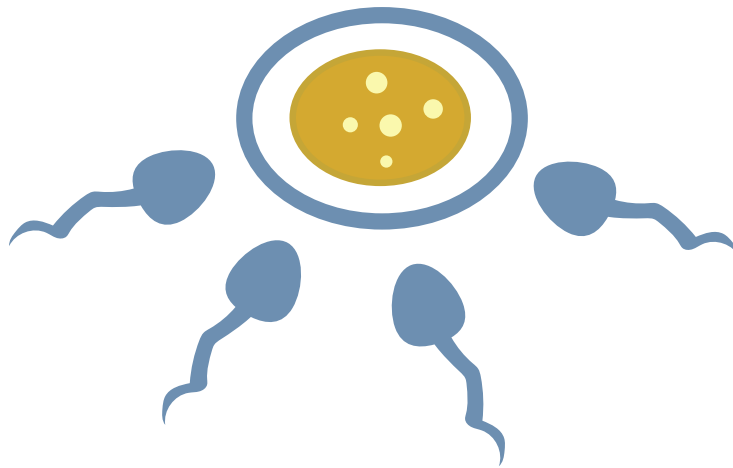
1. Increased heavy metals in the water reduce the coral's fertilization rates.
2. Temperatures rise and cause stress to the zooxanthellae in the coral.
3. An algal bloom occurs.
4. Factors relating to water temperature and lunar cycles lead to delayed spawning.
5. Coral is killed when a swimmer who is snorkeling stands on it.
6. Water quality is good! The coral is ready to spawn. Move on to stage 2.



PHASE 2 - SPAWNING: GAMETE

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

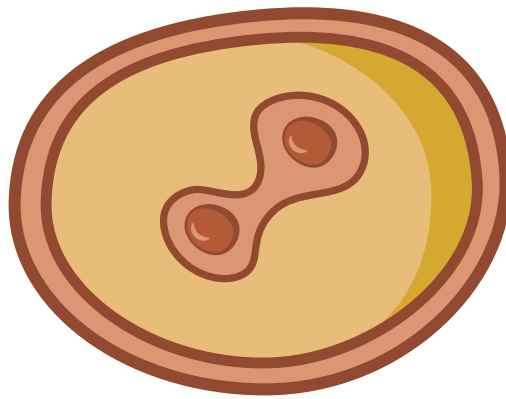
1. Sperm and eggs in broadcast spawning are released asynchronously and are therefore unable to fertilize each other.
2. Spawning was out of sync, again.
3. Gametes are eaten by small animals.
4. Sediments in the water bind to eggs, making them sink to the bottom instead of floating during spawning.
5. Eggs are damaged by insecticides in the water.
6. Corals successfully spawned! A gamete was produced. The cells are dividing, and you quickly become a zygote. Move on to stage 3.



PHASE 3 - ZYGOTE

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

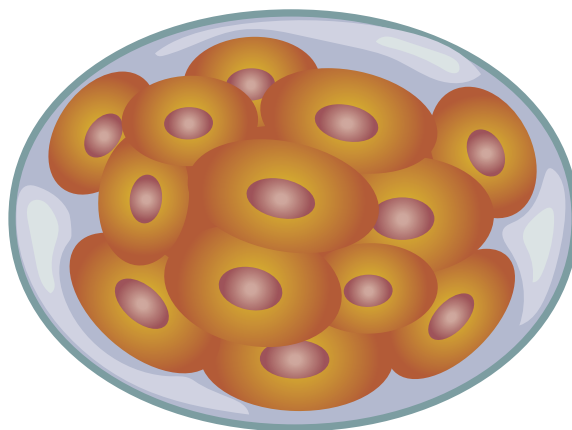
1. High temperatures in the water kill the zygote.
2. Pollution prevents the zygote from developing properly.
3. Pesticides in the water lead to deformations and loss of normal swimming behavior.
4. Land-based stormwater runoff degrades water quality.
5. Eaten by zooplankton.
6. You survived the zygote stage despite all the challenges, and your zygote grew to an embryo!
Move on to stage 4.



PHASE 4 - EMBRYO

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

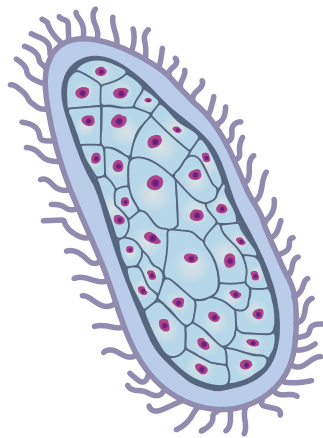
1. Oxybenzone, an active ingredient in some sunscreens, damages the zygote's DNA.
2. A storm's strong currents make the embryo drift away from suitable habitat.
3. Pollutants affect an embryo's development.
4. Algal blooms over the coral reef block sunlight from reaching the embryo.
5. Eaten by small fish.
6. The embryo continues to develop and grows into a planula. Move on to stage 5.



PHASE 5 - PLANULA

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

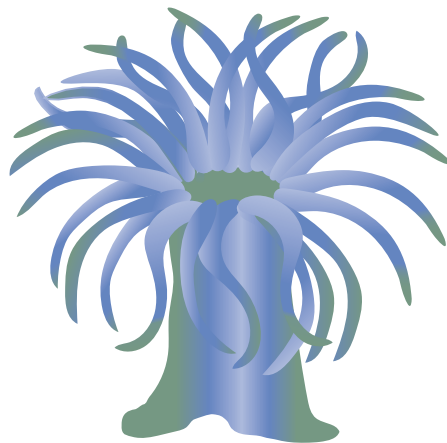
1. High turbidity prevents the planula from settling down in a good location near coralline algae.
2. Pollutants affect the metabolic functions of larvae.
3. Fish and other sea creatures prey on the planula.
4. Increased sediments in the water block the sunlight, preventing the zooxanthellae in the coral's tissues from photosynthesizing.
5. High temperatures kill the planula.
6. The planula settles on a suitable hard substance and becomes a polyp. Move on to stage 6.



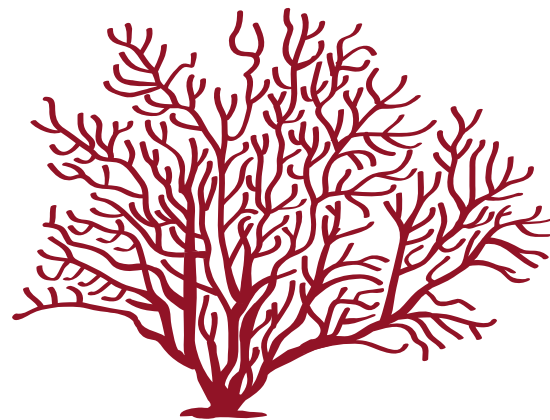
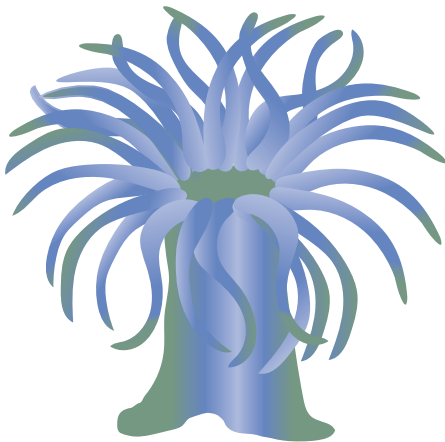
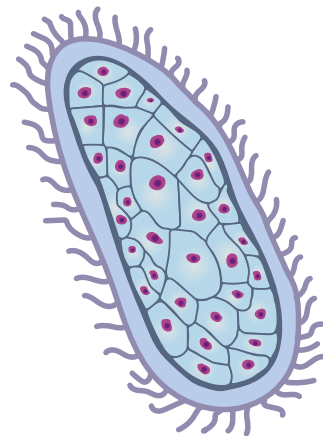
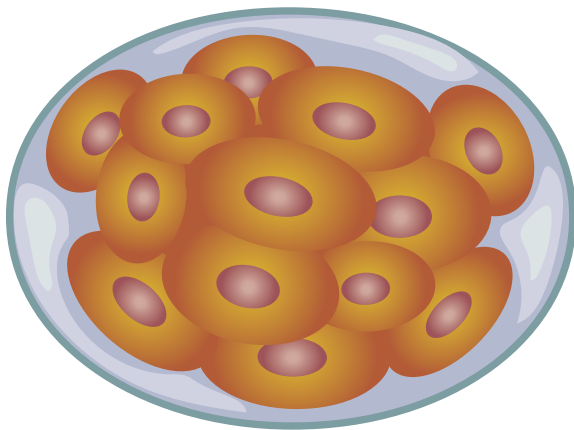
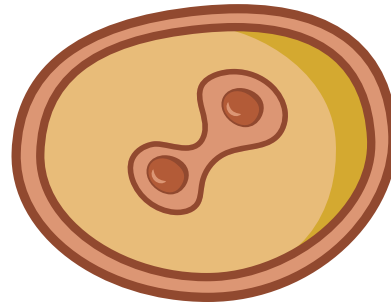
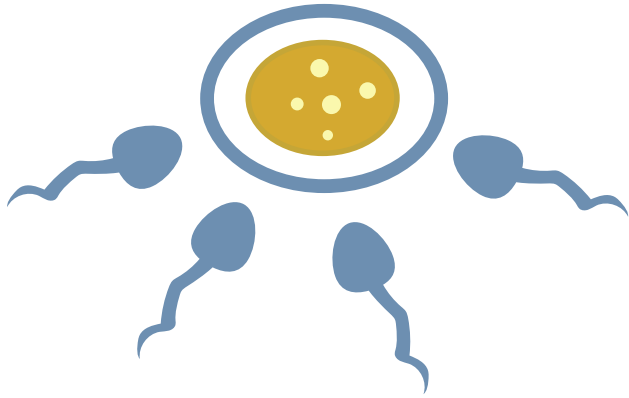
PHASE 6 - JUVENILE POLYP

The number you roll tells you what happens to you at this stage. Roll the die, read and record what happens, and keep rolling until you roll a 6, which allows you to move to the next stage of development.

1. Coral polyp cannot secrete its calcium carbonate skeleton due to acidifying waters that have a lower pH than desirable for coral survival.
2. Herbicides affect the zooxanthellae's ability to photosynthesize.
3. Untreated sewage released in the water contains pathogens that kill the coral.
4. Coral polyp is eaten by a parrotfish.
5. Coral was collected by a swimmer.
6. Coral polyp grows and becomes a mature coral that can reproduce. Move on to stage 1.



GROWING UP CORAL: CORAL REEF REPRODUCTION GAME ICONS TO PRINT AND CUT





Hyperlink Web Addresses

Page 3

- ¹ [YouTube.com/watch?v=rpKSQM2cDk0&t=194s](https://www.youtube.com/watch?v=rpKSQM2cDk0&t=194s)
- ² [YouTube.com/watch?v=VorXse4HrHs](https://www.youtube.com/watch?v=VorXse4HrHs)

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- ³ [YouTube.com/watch?v=E9ITuAKLRuY](https://www.youtube.com/watch?v=E9ITuAKLRuY)
- ⁴ [YouTube.com/watch?time_continue=1&v=8xEEIlyVEhQ](https://www.youtube.com/watch?time_continue=1&v=8xEEIlyVEhQ)
- ⁵ [EPA.gov/Coral-Reefs/threats-coral-reefs](https://www.epa.gov/Coral-Reefs/threats-coral-reefs)
- ⁶ [LivingOceansFoundation.org/education/portal/course/life-cycle/](https://www.livingoceansfoundation.org/education/portal/course/life-cycle/)