

UNIT 9: CORAL GROWTH



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CORAL REEF ECOLOGY CURRICULUM



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This unit is part of the *Coral Reef Ecology Curriculum* that was developed by the Education Department of the Khaled bin Sultan Living Oceans Foundation. It has been designed for secondary school students, but can be adapted for other uses. The entire curriculum can be found online at lof.org/CoralReefCurriculum.

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STANDARDS

- **CCSS:** RST.9-10.1, 2, 3, 4, 5, 7, 8, 9, 10; RST.11-12.1, 2, 3, 4, 7, 8, 9, 10; W.9-10.1, 2, 4, 7, 8, 9; W.11-12.1, 2, 4, 7, 8, 9; SL.9-10.1, 4, 6; SL.11-12.1, 4, 6
- **NGSS:** ESS 2.D, HS-LS4-4, HS-LS4-5, HS-LS2-6, HS-PS1-5, PS 1.B
- **OLP:** 2.B.7, 3.B.4, 5.B.1, 5.B.5, 5.C.23, 5.C.33, 5.C.34, 5.C.35

ONLINE CONTENTS

- [Coral Growth Quiz](#)

CORAL GROWTH

This lesson is a part of the *Coral Growth* unit, which explains how corals grow, and the shapes that they form. Below is a summary of what is included in the entire unit.

UNIT CONTENTS

A. [Background Information](#)

- How do Corals Grow?
- Growth Rates

B. Lessons

[Candy Coral](#)

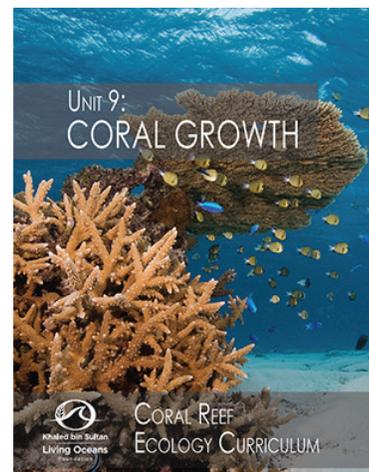
- A lab to simulate coral skeleton growth in different scenarios

[Which is the Superior Coral?](#)

- A debate over which coral growth form is the best

[Read it! Investigating the Reef Slope](#)

- A worksheet to accompany the [Investigating the Reef Slope](#) field blog



BACKGROUND INFORMATION

A) HOW DO CORALS GROW?

In *Unit 5: Coral Reproduction*, we learned that corals are able to create more coral polyps by reproducing sexually and asexually, but this doesn't explain how their skeletons are built. Stony corals increase the size of their skeletons by gradually depositing layers of **calcium carbonate (CaCO₃)**. This process is known as calcification. **Calcification** is the rate at which corals create their hard skeletons by absorbing calcium from seawater. In this unit, we will learn how corals grow and the shapes that they form.

How do corals grow? In colonial corals, each **polyp** contributes to the growth of the coral (figure 9-1). The polyp lifts itself up out of the cup-like skeleton, called the **corallite**. Then it deposits calcium carbonate in the space below. The polyp secretes this mineral from the **basal plate**. This layer of calcium carbonate allows the coral skeleton to grow upward. For more information about the structures of a coral polyp see *Unit 3: Coral Anatomy*.

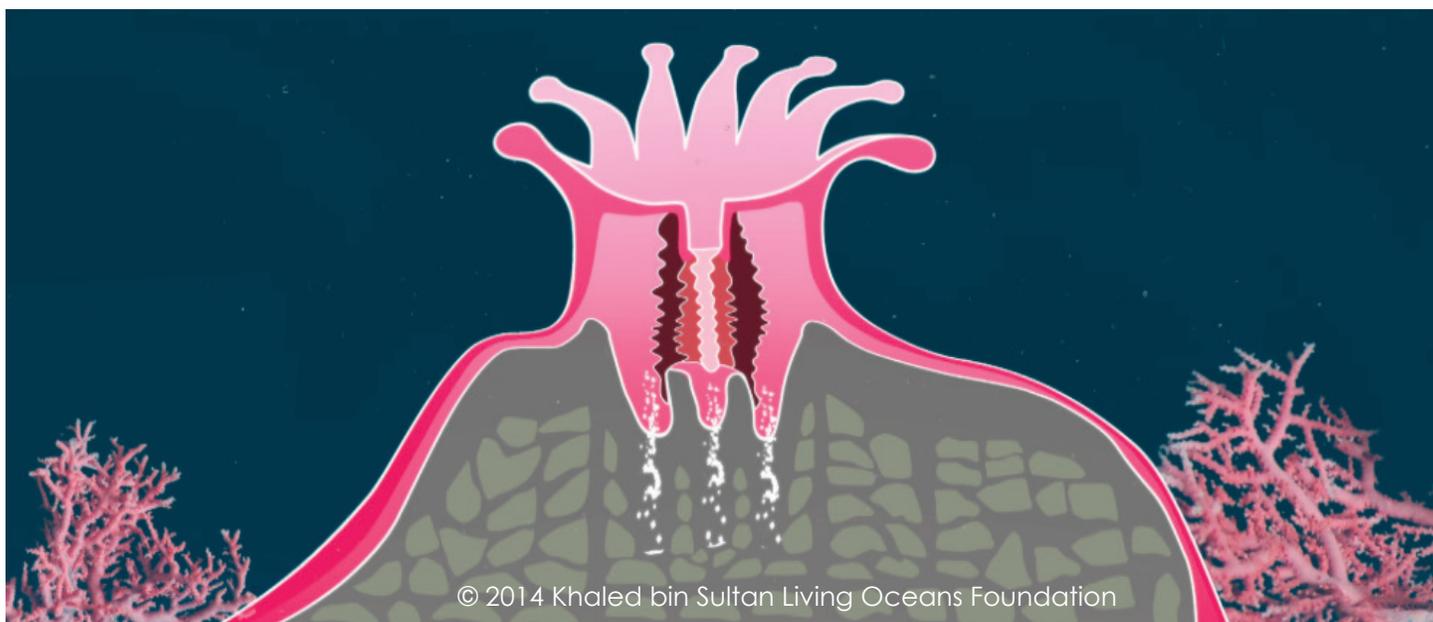


FIGURE 9-1. Cross section of a coral polyp - the polyp is lifting out of the corallite and depositing calcium carbonate in the space below.

Polyps create calcium carbonate through a **chemical reaction** (see *Unit 4: Coral Feeding section B* Photosynthesis). This reaction takes place inside the tissues of the coral polyp. Corals begin this process by pulling calcium and carbonate from the surrounding seawater. Here is the calcification chemical equation:



Bicarbonate + Calcium → Calcium carbonate + carbon dioxide + water

Scientists are not entirely sure how some of this process occurs.

B) GROWTH RATES

Some coral species have faster growth rates than others. Their growth rate depends on their rate of calcification; the greater the calcification, the greater the growth rate.

Let's take a look at two different species of coral in the northeastern Caribbean, *Acropora palmata* or elkhorn coral (figure 9-2a) is a very important reef-building coral in the Caribbean and Florida. It has a fast growth rate of up to 4 inches (10 cm) per year (Gladfelter *et al.* 1978). Other corals are slower growing, such as the boulder star coral, *Montastraea annularis* (figure 9-2b). This coral only grows about 0.3 inches (7.6 mm) per year (Gladfelter *et al.* 1978).

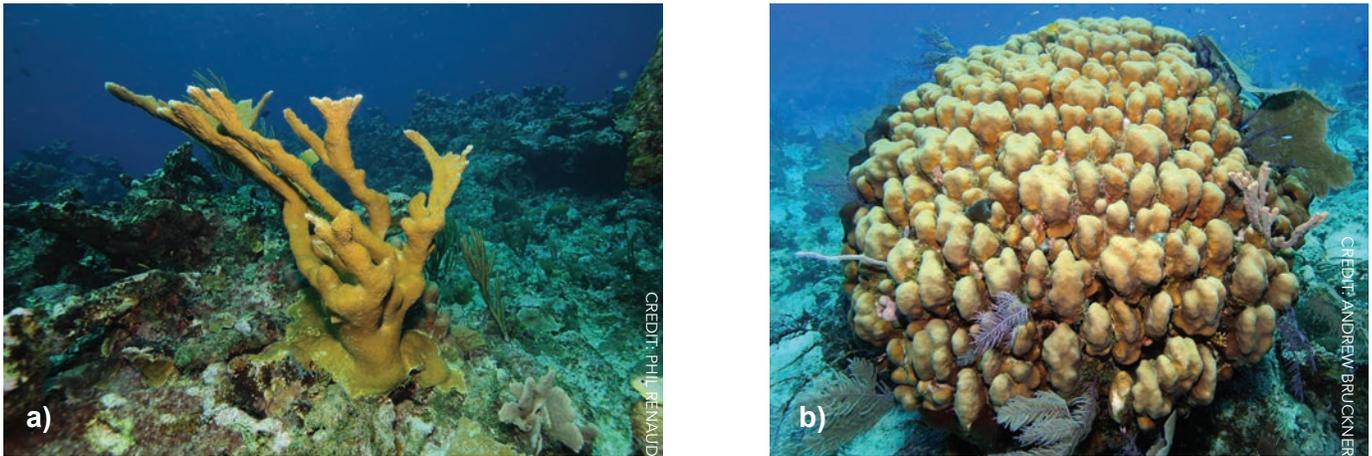


FIGURE 9-2. a) *Acropora palmata*; b) *Montastraea annularis*

Corals require a lot of energy for calcification to take place. The energy mainly comes from the photosynthesizing **zooxanthellae**. Corals photosynthesize (see *Unit 4: Coral Feeding*) more during the day when there is greater light availability. Research shows that corals also have higher levels of calcification during the day than at night when it's dark (Kawaguti & Sakumoto 1948; Gattuso *et al.* 1999). Since photosynthetic activity affects the amount of calcification in corals, this process is often referred to as **light-enhanced calcification**.

Growth rates of corals are also determined by environmental factors (see *Unit 8: Environmental Conditions*). Here are some of the main factors that influence photosynthesis and the calcification process.

- **Temperature:** Studies show that corals calcify best when the **temperature** is stable and at an optimal range (Clausen & Roth 1975; Coles & Jokiel 1978; Marshall & Clode 2004). This range is different depending on the coral species and their location, but most prefer somewhere between 60.8–86°F (16–30°C).
- **Calcium carbonate saturation:** The amount of calcium and carbonate in the ocean is called **calcium carbonate saturation**. Corals need calcium and carbonate to create their skeletons. A low calcium carbonate saturation inhibits calcification.
- **Turbidity:** Corals receive less sunlight when **turbidity** is high because the particles block the sunlight. This inhibits photosynthesis from taking place.
- **Sedimentation:** **Sedimentation** takes place when **sediment** particles are suspended in the water. Corals that are smothered by sediment, receive less sunlight. This also inhibits photosynthesis from taking place.
- **Salinity:** Corals calcify at an optimal **salinity** range. The more stable the salinity, the more likely corals will calcify. Again, this varies per coral species, but is usually between 23-42 ppt.
- **pH:** As the **pH** of seawater becomes more acidic, it inhibits calcification. We will learn more about this process when we discuss ocean acidification in *Unit 19: Threats*.

- **Currents:** When water flow is greater, corals are able to increase their calcification rate; however, too great of water movement can inhibit coral growth. Moderate water flow increases the exchange of gases (CO₂ and O₂), inorganic nutrients, and food availability. Corals need gases and inorganic nutrients to photosynthesize. As we just learned, the more corals photosynthesize, the greater their calcification rates. Moderate water flow also can allow for a greater abundance of food in the water. When corals are able to catch more food, they are able to gain more energy allowing corals to be able to increase their ability to create their stony skeletons. For more on currents see *Unit 7: Distribution*.

C) GROWTH FORMS

Why would scientists need to know a coral's growth form? Corals are very difficult to identify. Using their growth forms can help scientists identify corals.

As corals grow, they begin to take certain shapes or forms known as **growth forms**. Each stony coral can be classified by one of these growth forms. Additionally, there are some growth forms that have sub-categories. For simplification, we will learn about the main growth forms.

Branching (figure 9-3): Just like a tree, these corals form branches. These branches can also grow branches called secondary branches. They are not the sturdiest of corals and their branches can break off, but they can use this to their advantage. Branching corals can use **fragmentation**, a type of asexual reproduction, to create new coral colonies (see *Unit 5: Coral Reproduction*). These corals typically have faster growth rates than other growth forms.



FIGURE 9-3. a) *Acropora* sp.; b) *Pocillopora* sp.; c) *Acropora* sp.

Columnar (figure 9-4): These corals are cylindrical in shape and they look like fingers. Columnar corals grow upwards. They differ from branching corals in that they do not have secondary branches.

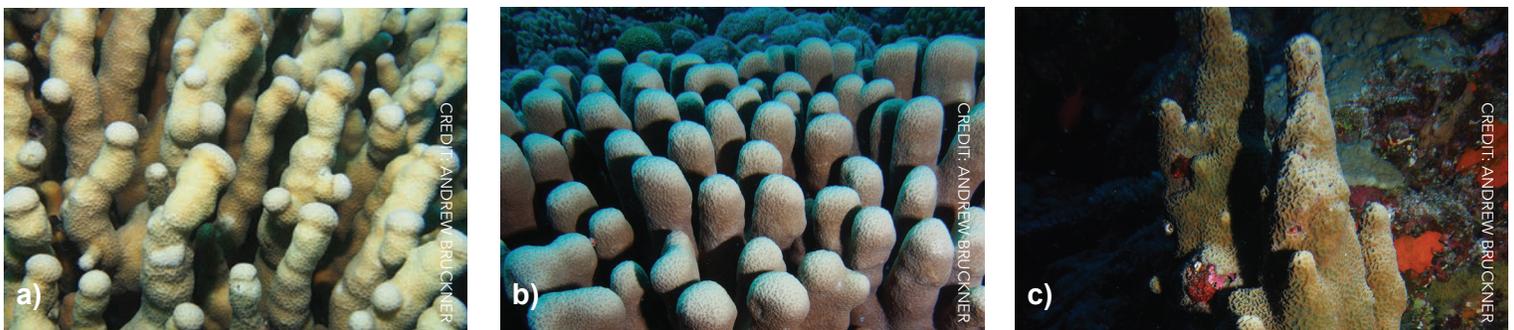


FIGURE 9-4. a) *Pavona clavus*; b) *Pavona clavus*; c) *Coscinaraea columna*

Encrusting (figure 9-5): This form typically adheres to rocky substrates. Encrusting corals do not grow upwards, but instead they grow outward, covering the rocky surface. These corals are able to withstand a great amount of wave action.

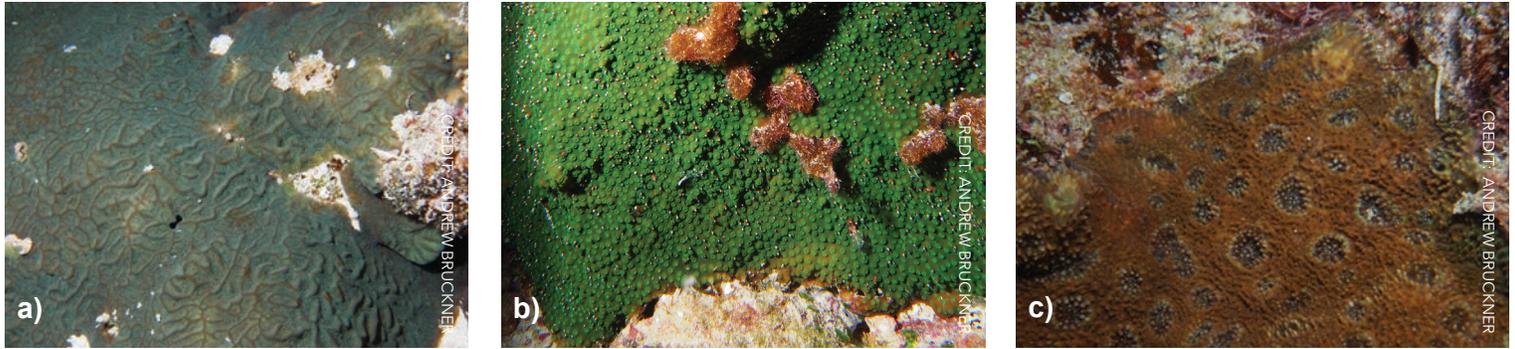


FIGURE 9-5. a) *Pavona varians*; b) *Cyphastrea* sp.; c) *Acanthastrea echinata*

Foliose (figure 9-6): Corals form growth patterns like layered petals in an open flower. These folds increase surface area in order to obtain the maximum amount of sunlight so that their zooxanthellae can photosynthesize.



FIGURE 9-6. a) *Astreopora randalli*; b) *Merulina ampliata*; c) *Turbinaria* sp.

Free-living (figure 9-7): Not all corals are colonial; some are solitary. Free-living corals are individual coral polyps. They are typically round, oval, or oblong. Some are free-living, while others are attached to a substrate.



FIGURE 9-7. a) *Fungia* sp.; b) *Fungia* sp.; c) *Herpolitha limax*

Massive (figure 9-8): These corals look like domed boulders. They are slow growing and sturdy. They can withstand strong wave action.



FIGURE 9-8. a) *Astreopora myriophthalma*; b) *Favites* sp.; c) *Platygyra sinensis*

Phaceloid (figure 9-9): Each corallite has an individual wall. The corallite is tubular in shape and extends from a common base.



FIGURE 9-9. a) *Lobophyllia corymbosa*; b) *Lobophyllia hemprichii*; c) *Caulastrea furcata*

Plating (figure 9-10): They are thin, plate-like corals. They grow horizontally and look like shelves. Often, plating corals are found in deeper parts of the **fore reef** (see Unit 11: Zonation). Like foliose corals, they grow horizontally, increasing their surface area in order to obtain the maximum amount of sunlight, so that their zooxanthellae can photosynthesize. This plate-like structure also allows these corals to catch food that is drifting down the reef slope.



FIGURE 9-10. a) *Leptoseris* sp.; b) *Mycedium* sp.; c) *Merulina ampliata*

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CORAL REEF ECOLOGY CURRICULUM

The Coral Reef Ecology Curriculum is a comprehensive educational resource designed to educate people about life on coral reefs. Developed by educators and scientists at the Khaled bin Sultan Living Oceans Foundation, this curriculum strives to increase ocean literacy by creating awareness about coral reefs, the threats they face, and how people can help to preserve these diverse ecosystems.



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The Khaled bin Sultan Living Oceans Foundation is a US-based nonprofit environmental science organization. The Foundation was established to protect and restore the world's oceans through scientific research, outreach, and education.