IMARCS FOUNDATION

CLASSROOM UNIT 01

# Coral Reefs, Giant Clams, and Responsible Stewardship

A ready to teach marine science unit. Nothing needed but a printout and a pencil.

| GRADES | CLASS TIME | INCLUDES | COST |
| --- | --- | --- | --- |
| 5 to 8 | 45 to 60 min | Reading, worksheet, answer key | Free to copy |

# Teacher Overview



**What this is.** A short, self-contained marine science unit built around one big idea: coral reefs are valuable, living systems, and people can be responsible stewards of them. It runs in one class period and stretches into a longer unit if you use the optional demo and the extension questions.

## What students do

Students read seven short sections, build vocabulary, label a diagram, map a simple reef food web, think like a working scientist, and finish by naming concrete ways they can be responsible stewards of the ocean. The giant clam is the anchor animal throughout.

## Learning objectives

By the end of this unit, students can:

- Explain what a coral reef is and name several reasons reefs matter to living things and to people.
- Describe a partnership between two different living things and tell how each one is helped.
- Explain how giant clams and corals use symbiotic algae and photosynthesis to make glucose, and why this gives clams their color.
- Explain that giant clams can be a responsible food source when they are farmed instead of taken from wild reefs.
- Describe what happens when reef animals are put under stress by warm water.
- Define stewardship and give real examples of being a responsible steward.

## Vocabulary preview

steward, stewardship, symbiosis, mutualism, mantle, symbiotic algae (zooxanthellae), photosynthesis, glucose, bleaching, filter feeder, mariculture, pH

> **Always looking to go further.** The IMARCS Foundation is always looking to expand our work with classrooms. Reach out any time with requests for more units or for a custom lesson built around your class and your goals. Whatever your STEM objectives, we are happy to help however we can. Contact Jordan Flagel at jordan@imarcs.org.

**TIME REQUIRED**

45 to 60 minutes core.
Add 20 to 30 minutes for the optional class demo.

**GRADE BAND**

US grades 5 to 8. Scales down to grade 4 with lighter reading, and up to grades 9 to 10 with the extension questions.

**MATERIALS**

This packet and a pencil per student.

For the optional demo: one red cabbage, hot water, clear cups, white vinegar, baking soda.

**STANDARDS**

A verified NGSS crosswalk is included at the back of this packet.

**CONNECT YOUR CLASS**

**imarcs.org/curriculum**

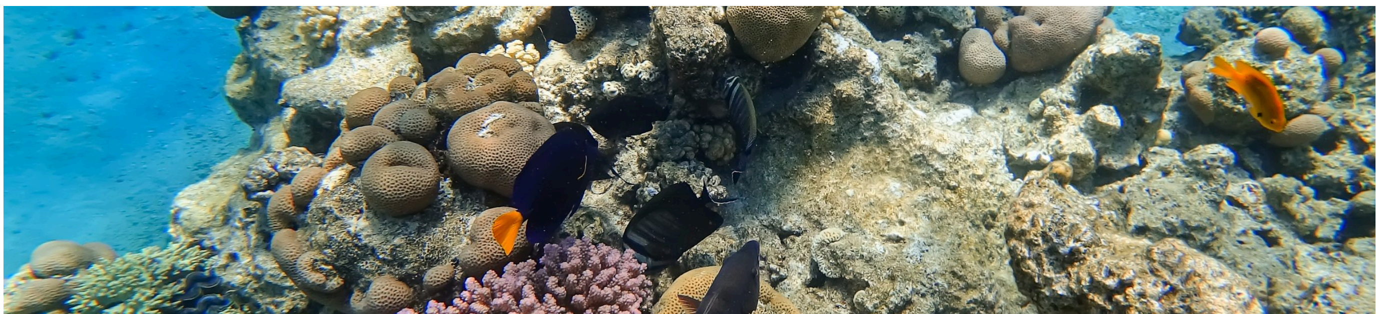
Follow a real research tank, arrange a visit near Osaka, or adopt a giant clam, a clownfish pair, or a coral.

# Student Reading

## 1 What is a coral reef?

A coral reef is a living structure built in warm, shallow seawater. Corals are small animals that live together in large groups called colonies. Over long stretches of time, corals build hard, rocky structures. These structures grow into reefs.

Reefs are some of the busiest places in the whole ocean. Only a tiny slice of the sea floor is covered by reefs, yet a huge share of ocean animals depend on them at some point in their lives. Reefs give animals food and a place to hide, raise young, and find mates. Reefs also protect coastlines. The reef acts like a wall that softens waves before they reach the shore. And reefs matter to people, who fish near them, dive to see them, and rely on the coastlines they protect.

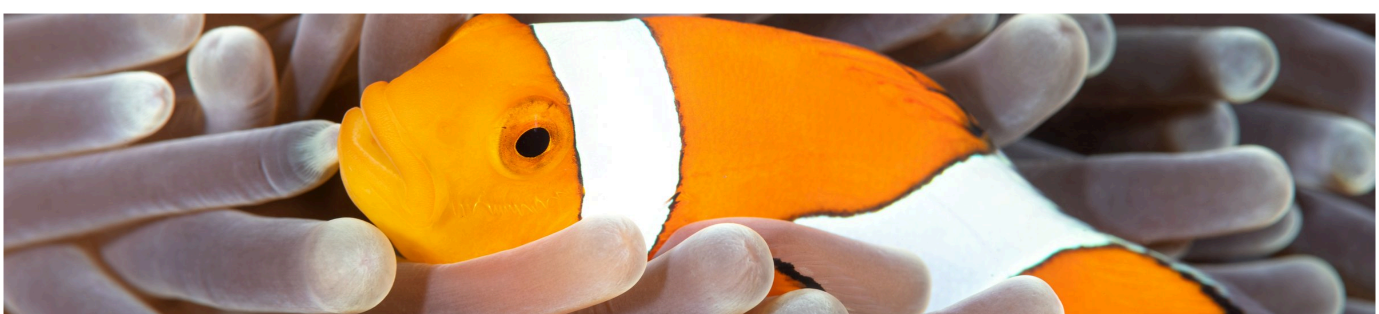


**A shallow coral reef.** Only a tiny slice of the sea floor is reef, yet a huge share of ocean animals depend on it.

## 2 Partners on the reef

Many reef animals get along by teaming up. When two different kinds of living things live closely together, scientists call it **symbiosis**. When both partners are helped, it is called **mutualism**.

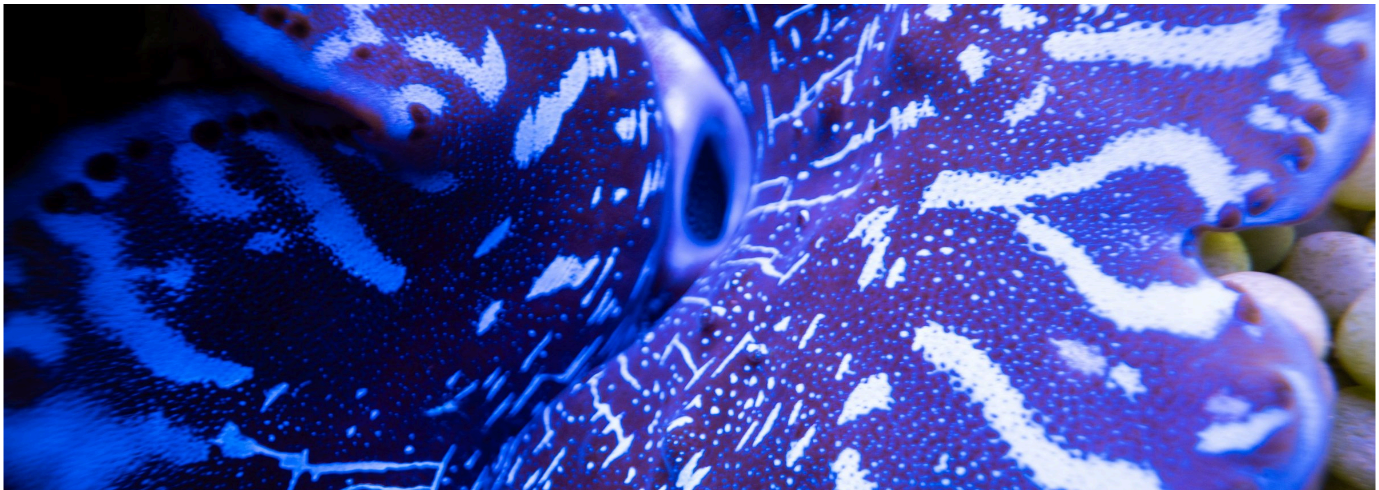
The clownfish and the sea anemone are famous partners. A sea anemone has tentacles armed with tiny stinging cells called **nematocysts** (pronounced nee-MAT-oh-sists), which work like microscopic harpoons and keep most fish away. The clownfish isn't most fish. Its body is coated in a special mucus layer that lets it move among the tentacles without being stung. Inside the anemone, the clownfish is safe from larger fish that would eat it. In return, the clownfish helps keep the anemone clean and chases away animals that would nibble on it. Both partners come out ahead. That's mutualism.



**Mutualism in action.** The anemone's sting protects the clownfish. The clownfish keeps the anemone clean and drives off animals that would nibble it.

## 3 Giant clams: living color

Giant clams are the largest clams in the ocean. Some kinds can grow very large and can live for a very long time. If you look at a giant clam underwater, the first thing you notice is the bright, fleshy part between its two shells. That colorful part is called the **mantle**, and its color isn't just for show.



**The mantle up close.** The color comes from symbiotic algae living inside the clam and from pigments that help it manage strong sunlight. The dark oval opening is the siphon, where water leaves the clam.

The mantle is full of tiny plant-like living things called **symbiotic algae**, also known as **zooxanthellae** (pronounced zo-oh-zan-THELL-ee). These algae are so small you would need a microscope to see one. They live inside the clam, safe and in the light. Using sunlight, they carry out **photosynthesis** (photosynthesis is the process plants and algae use to turn sunlight into food). They make a simple sugar called **glucose** (glucose is a sugar that living cells use for energy), and they share much of it with the clam. In return, the clam gives the algae a protected, sunny home. This is another partnership, just like the clownfish and the anemone. The bright colors of the mantle come from these algae and from special pigments that help the clam manage strong sunlight.

Giant clams are also **filter feeders**. As a clam sits on the reef, it draws seawater in, strains tiny bits of food out of the water, and pushes the cleaned water back out. So, a giant clam feeds itself two ways at once: from the glucose made by the algae in its mantle, and from the food it filters out of the water.

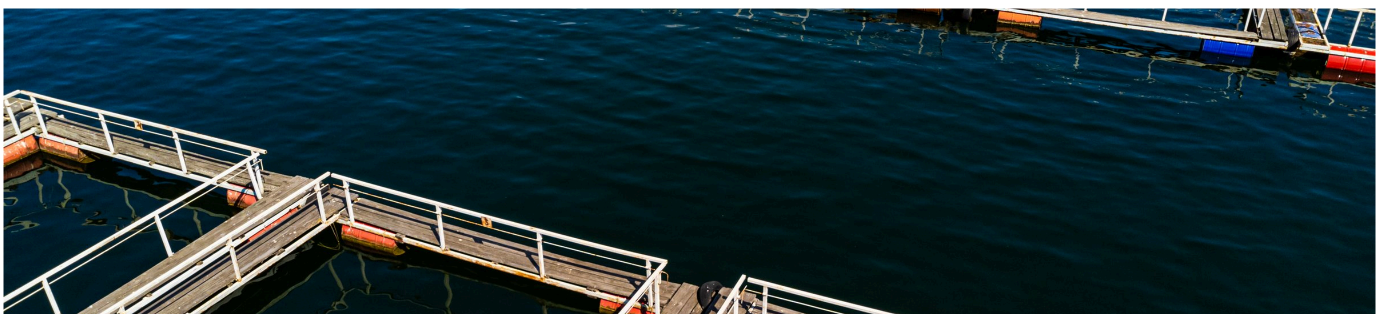
> **Two meals at once.** Sunlight feeds the algae. The algae feed the clam. The clam also strains its own food from the water. Not many animals eat in two completely different ways.

## 4 Clams on the table

Giant clams are more than beautiful. In many island cultures across the Pacific, people have eaten giant clams for a very long time. The large muscle and the mantle are used as food, and clams have long been part of local meals and trade.

Here's the problem, and the lesson. In some places, people took wild giant clams off the reefs faster than new clams could grow to replace them. When that happens, the wild clams start to disappear, and the reef loses an animal that helps keep it healthy.

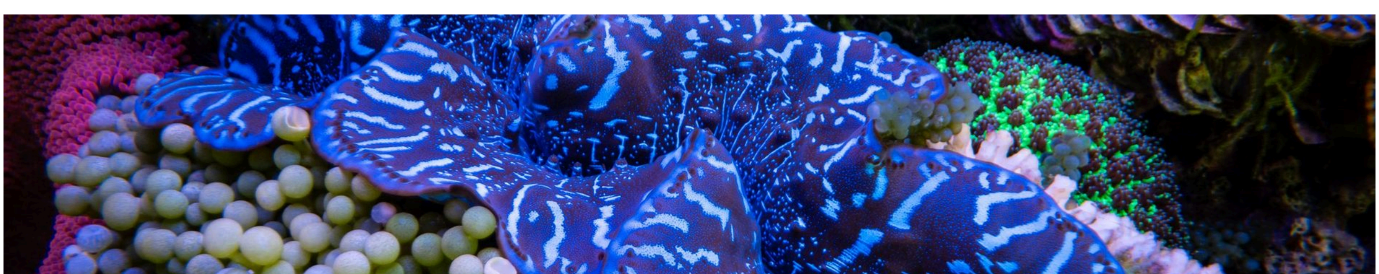
So, people found a better way. Instead of stripping clams from wild reefs, they learned to raise giant clams on farms in seawater. Raising ocean animals or plants on a farm like this is called **mariculture** (which comes from the combination of the words "marine" and "aquaculture"). Mariculture can also refer to marine animals and plants raised in saltwater tanks onshore or inland. Farmed clams can be grown for food and for income, while the wild clams on the reef are left alone to do their job. Some farms even raise young clams and place them back onto reefs that need them.



**Ocean farming.** Growing animals in the water on a farm means fewer animals have to be taken from wild reefs. Farms like this one raise seafood in pens instead of harvesting it from the reef.

This is the heart of good stewardship. Being a responsible steward doesn't always mean don't touch. It can mean use it wisely, so there is enough now and enough later. A well-run clam farm feeds people and protects wild reefs at the same time.

> **Think about it.** Farming doesn't mean the reef gets used less. It means the reef gets used wisely. That is the difference between taking and stewarding.



**An essential part of the ecosystem.** A giant clam shares its patch of reef with corals, fish, and hundreds of smaller animals. If even one species were to disappear, it could cause a cascade of changes among the others.

## 5 When reefs are under stress

Reef animals are tough, but they have limits. Giant clams and corals both depend on the tiny symbiotic algae living inside them. That partnership works well only when conditions stay in a healthy range.

When seawater gets too warm (even by a fraction of a degree) and stays too warm, corals and clams become stressed. Under that stress, they push out their symbiotic algae. Without the algae, the animal loses much of its color and turns pale or white. Scientists call this **bleaching**. A bleached coral isn't dead, but it's in trouble. If the stress ends soon, the algae can return and the animal can recover. If the stress goes on too long, the coral or clam can die.

**Bleached coral.** The pale, bone-white coral in front has pushed out its symbiotic algae. Healthy coral behind it still holds its color.

## 6 The water itself

The ocean isn't just water. It's water mixed with gases, salts, and minerals, and the balance of that mixture matters to reef life. One useful measurement scientists use is **pH**, which tells you how acidic or how basic (also called alkaline) the water is. Corals and clams build their hard shells and skeletons out of a mineral called **calcium carbonate** (calcium carbonate is the same material found in chalk and in seashells), which they take from the seawater. The pH of the water affects how easily they can build with it.

Ocean chemistry is changing, and IMARCS scientists are studying how those changes affect giant clams and corals. IMARCS scientists are also studying whether giant clams that build thick, heavy shells might lock away material inside those shells for a very long time, and whether giant clams can help filter tiny bits of plastic out of seawater. These are open questions that scientists are still working on, which is exactly what research is: careful work on questions we don't yet fully understand.

**Built from seawater.** A giant clam's shell is made of calcium carbonate, the same mineral found in chalk, taken from the water around it.

# Student Reading

## 7 Becoming a responsible steward

A **steward** is a person who takes care of something valuable that has been placed in their trust. **Stewardship** means taking care of that thing so it stays healthy and useful for a long time, including for the people who come after us.

**Stewardship is work.** A researcher tends a structure where young corals are growing. Careful hands-on work like this is how damaged reefs are helped back toward health.

You don't have to live near a reef to be a responsible steward of the ocean. Water flows from streets and drains toward the sea, so keeping trash and plastic out of gutters and off beaches helps. Choosing seafood that comes from responsible farms and fisheries helps. Not wasting water helps. And learning how the ocean works, then teaching someone else, may help most of all, because a reef is safest when the people around it understand why it matters and choose to care for it well.

> **The short version.** A steward doesn't just leave things alone, and doesn't just take. A steward takes care of something valuable so that it lasts.

**What stewardship protects.** A healthy giant clam on a healthy reef, filtering water and feeding itself on sunlight, exactly as it has always done.

# Worksheet



Name

Date

## PART A Vocabulary match

*Draw a line from each word to its meaning.*

| | |
|---|---|
| **1. Steward** | A. Two different living things living closely together. |
| **2. Stewardship** | B. When a coral or clam loses its algae and turns pale or white. |
| **3. Symbiosis** | C. A person who takes care of something valuable placed in their trust. |
| **4. Mutualism** | D. The colorful, fleshy part of a giant clam between its shells. |
| **5. Mantle** | E. Raising ocean animals or plants on a farm in seawater or in saltwater tanks. |
| **6. Symbiotic algae** | F. A partnership in which both living things are helped. |
| **7. Photosynthesis** | G. Tiny plant-like living things that make food from sunlight inside a clam or coral. |
| **8. Glucose** | H. Taking care of something so it stays healthy and useful for a long time. |
| **9. Bleaching** | I. A measure of how acidic or basic the water is. |
| **10. Filter feeder** | J. An animal that strains tiny bits of food out of the water. |
| **11. Mariculture** | K. The process plants and algae use to turn sunlight into food. |
| **12. pH** | L. A simple sugar that living cells use for energy. |

## PART B Comprehension

*Answer in one or two sentences.*

1. Give two reasons coral reefs matter.

2. How does the clownfish survive among the anemone's stinging tentacles?

3. Where do a giant clam's symbiotic algae live, and what do they make and share with the clam?

4. Name the two ways a giant clam gets its food.

5. Why is farming giant clams better for wild reefs than taking clams off the reef?

# Worksheet



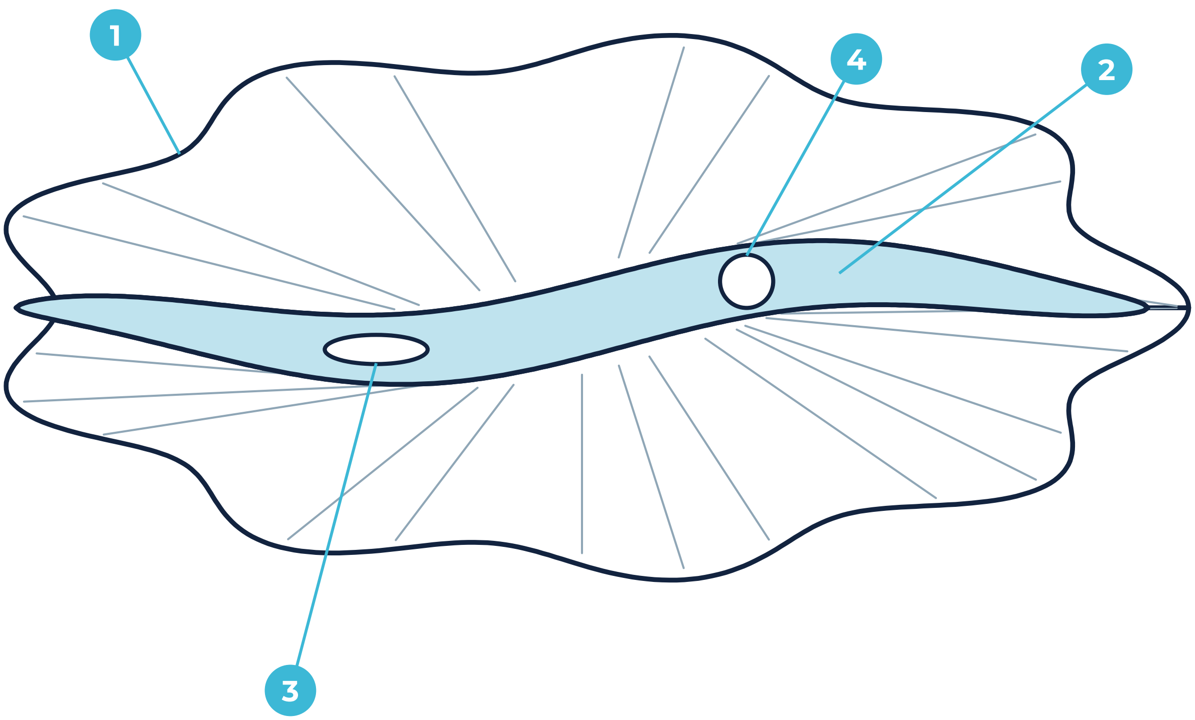
## PART B Comprehension, continued

6. What is bleaching, and what causes it in this reading?

7. In your own words, what does it mean to be a responsible steward?

## PART C Label the giant clam

*Label the diagram using the words in the box below.*




1. ______________________ 2. ______________________

3. ______________________ 4. ______________________

**Word box:** shell · mantle (holds the symbiotic algae) · incoming water opening · outgoing water tube

# Worksheet



## PART D Map the reef

*Draw arrows to show how energy and food connect on the reef. Start each arrow at the source.*

| Sunlight | Symbiotic algae | Giant clam | Small reef fish | Larger fish |
| --- | --- | --- | --- | --- |

Then answer: If the symbiotic algae were removed, name one animal in your map that would be affected, and explain why.

## PART E Think like an IMARCS scientist

> IMARCS scientists are studying whether giant clams that grow thick, heavy shells might store material inside those shells for a very long time.

1. If you wanted to find out whether a clam's shell is getting bigger and heavier over time, what two things would you measure?

2. How often would you measure them, and why?

**Extension.** Design a simple experiment to compare shell growth in two groups of clams kept under different water conditions. What would you keep the same in both groups, and why does that matter?

# Worksheet



## PART F Optional class demo: seeing pH

*Your teacher will make a purple liquid from red cabbage. Watch what happens when acid and base are added.*

1. When vinegar (an acid) is added, the color turns ____________________.

2. When baking soda solution (a base) is added, the color turns ____________________.

3. What does this tell you about how you could measure the pH of water?

## PART G Be a responsible steward

*List three things you could actually do to be a responsible steward of the ocean, even living far from a reef.*

1.

2.

3.

**Want to go further?** You can take part in IMARCS stewardship. Ask your parents to visit **imarcs.org** for more information.

**Tridacna on the reef.** A giant clam wedged into the coral, mantle open to the sunlight.

# Answer Key



### Part A. Vocabulary match

1-C 2-H 3-A 4-F 5-D 6-G 7-K 8-L 9-B 10-J 11-E 12-I

### Part B. Comprehension

1. Any two: home and shelter for many animals, food, a place to raise young, protection of coastlines from waves, value to people through fishing and diving.
2. Its body has a special mucus layer that lets it move among the tentacles without being stung.
3. Inside the clam's mantle, in the light. Using photosynthesis they make glucose (a sugar) and share much of it with the clam.
4. From the glucose made by the symbiotic algae in its mantle, and by filtering tiny food out of the water.
5. Farming grows clams for food without removing clams from wild reefs, so the wild clams stay and keep the reef healthy. Some farms also return young clams to reefs.
6. Bleaching is when a coral or clam pushes out its symbiotic algae and turns pale or white. In this reading it is caused by water that gets too warm and stays too warm.
7. Answers vary. Look for the idea of caring for something so it stays healthy now and for the future, including wise use rather than only leaving it alone.

### Part C. Label the giant clam

Shell on the hard outer halves, mantle on the colorful fleshy part, and the incoming water opening and outgoing water tube on the two openings where water moves in and out.

### Part D. Map the reef

Arrows: Sunlight to Symbiotic algae, Symbiotic algae to Giant clam, plus a food chain such as Small reef fish to Larger fish. Accept reasonable maps. For the question, removing the algae most directly affects the giant clam, which depends on the algae for much of its food.

### Part E. Think like an IMARCS scientist

**1.** Reasonable measures: shell length or width, and shell weight. **2.** Repeated measurements over weeks or months, because growth is slow and needs time to show a clear change. **Extension.** A good design keeps everything the same except the one water condition being tested (same clam type, food, light, tank size), so any difference in growth can be linked to that one condition.

### Part F. Optional class demo

**1.** Pink or red. **2.** Blue or green. **3.** A color-changing liquid like this can act as a simple test to show whether water is more acidic or more basic.

### Part G. Be a responsible steward

Answers vary. Strong answers name concrete actions: keeping plastic and trash out of drains and off beaches, choosing responsibly farmed or fished seafood, saving water, and learning about the ocean and teaching others.

**Running the demo.** Simmer chopped red cabbage in hot water for about 10 minutes, let it cool, and pour off the purple liquid. Split it into clear cups. Adding vinegar shifts the color toward pink or red. Adding a baking soda and water solution shifts it toward blue or green. Cheap, safe, and reusable each year.

# NGSS Crosswalk



This unit aligns to the following Next Generation Science Standards performance expectations.

| CODE | PERFORMANCE EXPECTATION | WHERE IT IS COVERED | FIT |
|---|---|---|---|
| **MS-LS1-6** | Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. | Section 3. Zooxanthellae carry out photosynthesis and share glucose with the clam. | **Strong** |
| **MS-LS2-2** | Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. | Section 2, clownfish and anemone mutualism. Section 3, clam and algae partnership. | **Strong** |
| **MS-LS2-3** | Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. | Section 3 and Worksheet Part D, the reef food web mapping activity. | **Strong** |
| **MS-LS2-1** | Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. | Section 4. Wild clams removed faster than they are replaced. | **Partial** |
| **MS-LS2-4** | Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. | Section 5. Warm water as a stressor and the bleaching response. | **Strong** |
| **MS-LS2-5** | Evaluate competing design solutions for maintaining biodiversity and ecosystem services. | Section 4. Farming clams weighed against harvesting wild clams. | **Strong** |
| **MS-ESS3-3** | Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. | Section 7 and Worksheet Part G, the responsible steward actions. | **Strong** |

BRING REAL MARINE SCIENCE TO YOUR STUDENTS

# There’s more where this came from

The IMARCS Foundation works on giant clams, coral reefs, mangroves, and healthy ocean chemistry, and connects classrooms to that work.

- Follow a real research tank with your class.
- Near Osaka, arrange a live facility visit.
- Adopt a giant clam, a clownfish pair, or a coral.

imarcs.org/curriculum

The IMARCS Foundation is always looking to expand our work with classrooms. Reach out any time with requests for more units or for a custom lesson built around your class and your goals. Whatever your STEM objectives, we are happy to help however we can.

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