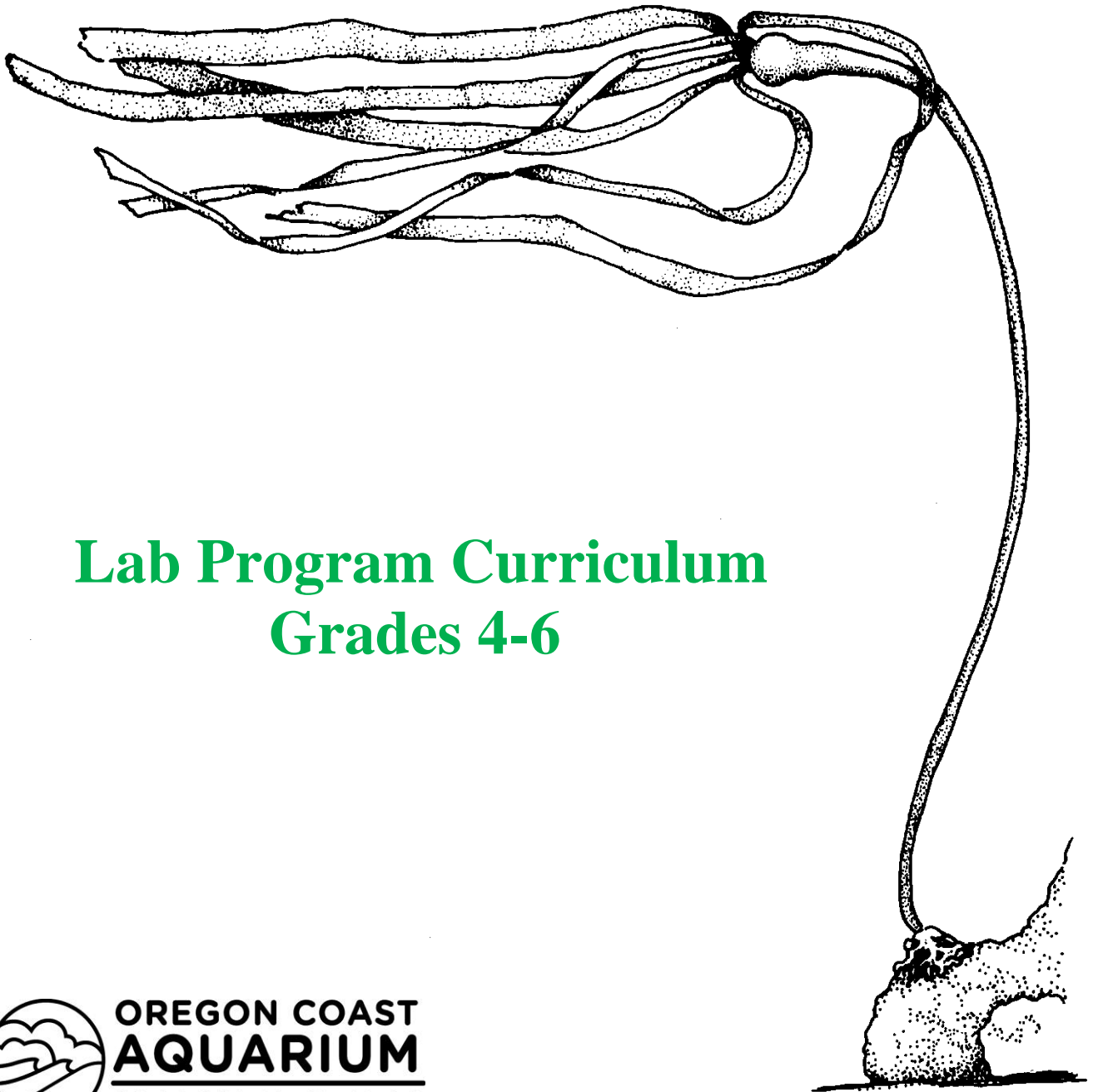


Forests Beneath the Sea



Lab Program Curriculum
Grades 4-6



OREGON COAST
AQUARIUM
NEWPORT

Program Description

This 45-60 minute lab program will introduce students to the similarities between a terrestrial forest and a kelp forest. During this program students will travel to four stations designed to help them become familiar with the adaptations of several kelp forest animals and learn to identify the parts of kelp. Students will have an opportunity to interact with live invertebrates and examine real kelp. Participating in this program and using the enclosed activities will help your students meet ODE Science Content Standards and national Ocean Literacy Principles.

Chaperones will be asked to take an active role in the lab program, which is designed so that they read informational cards to the students in their group. It will also be the chaperone's responsibility to monitor the students' behavior during the lab program.

Before your visit:

- Use the **Leaves to Roots** activity to introduce your students to the characteristics of a terrestrial forest habitat as compared to the kelp forest community.
- Provide each student with a copy of the **Background Information** and the **Kelp Words** activity to help them familiarize themselves with the vocabulary that they will encounter during their Aquarium lab program.

During your visit:

- Provide your students and chaperones with copies of the **Oregon Coast Aquarium Self Guided Materials**. A master copy of the pages needed to create this booklet can be found on the Teacher Resources page at the Aquarium website, www.aquarium.org
- Be sure to have your students visit the "Coastal Waters" exhibit where they will find two large kelp forests tanks. The "California Kelp Forest" and "Oregon Kelp Forest" tanks demonstrate the major similarities and differences in the two types of kelp forests. Have your students compare and contrast these two tanks to discuss at a later date. For example, how is the kelp different/similar? How are the animals different/similar? Etc.

After your visit:

- Use the **Kelp in Your Kitchen** activity to further explore the various human uses for algin, alginate and carageenan.
- Discuss possible human impact on this coastal habitat, for example, oil spills and the harvesting of kelp and invertebrates such as sea urchins and abalone.
- Use the **Recipe for Kelp Pickles** to make a tasty treat for your class!

Forests Beneath the Sea addresses the following:

ODE Science Content Standards:

- 4.1** Structure and Function: Living and non-living things can be classified by their characteristics and properties.
- 4.2** Interaction and Change: Living and non-living things undergo changes that involve force and energy.
 - 4.2L.1** Describe the interactions of organisms and the environment where they live.
- 5.1** Structure and Function: Living and non-living things are composed of related parts that function together to form systems.
 - 5.1L.1** Explain that organisms are composed of parts that function together to form a living system.
- 5.2** Interaction and Change: Force, energy, matter, and organisms interact within living and non-living systems.
 - 5.2L.1** Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.
- 6.1** Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.
- 6.2** Interaction and Change: The related parts within a system interact and change.
 - 6.2L.2** Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.

Ocean Literacy Principles:

Principle 4: The Ocean makes Earth habitable.

A: Most of the oxygen in the atmosphere originally came from the activities of photosynthetic organisms in the ocean.

Principle 5: The Ocean supports a great diversity of life and ecosystems.

E: The Ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

Principle 6: The Ocean and humans are inextricably interconnected.

A: The Ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. It moderates Earth's climate, influences our weather, and affects human health.

B: From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

G: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Background Information

Kelp

The largest, most conspicuous seaweeds are a group called kelp. Kelps grow best where sunlight reaches deep into clear, cold seawater. All the exposed parts of kelp absorb nutrients directly from the sea. Continuous waves and currents keep fresh, nutrient rich water moving past the plants.

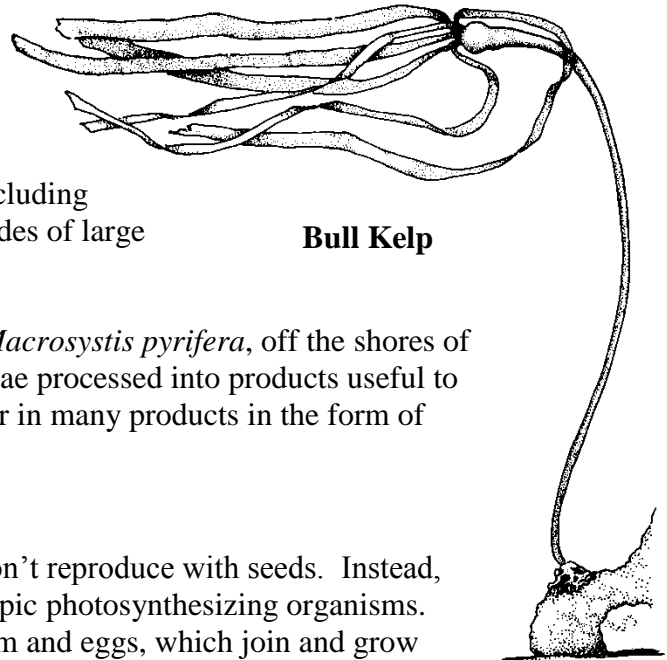
Many kelps, including the bull kelp, *Nereocystis luetkeana*, pictured on this page, look something like trees, with leaf-like blades, trunk-like stipes and root-like holdfasts.

Blades – The blades of a kelp function like the leaves of a tree. Along with most of the rest of the kelp, the blades collect sunlight for photosynthesis and absorb nutrients from seawater. Waves roll the broad, flexible blades about, exposing all sides to the sun and seawater.

Stipe – The stipe of a kelp is like a stem or trunk connecting the blades to the holdfast. It's flexible and strong enough to bend with the waves but not break. The stipe also brings some food from the blades at the surface to the holdfast below. On many types of kelp, several thin stipes grow from the same holdfast, offering less resistance to the wave surge than a single large stipe would.

Holdfast – Kelp is firmly attached to the seafloor by a holdfast. The holdfast has root-like branches, called haptera, which grow over the rocks and wedge themselves into cracks and crevices to anchor the kelp against the pull of the waves. Although it looks like a root, the holdfast gathers no nutrients or water; kelps depend on the blades in the sunlight above for nourishment.

Large kelps grow in forests just offshore and shelter an entire community of plants and animals beneath their floating fronds. Buoyed up by floats, called pneumatocysts, that act like small balloons filled with a mixture of gases including nitrogen, oxygen and carbon monoxide, the blades of large kelps form a canopy on the water's surface.



Bull Kelp

Kelp forests, especially forests of giant kelp, *Macrosystis pyrifera*, off the shores of California, are sometimes harvested and the algae processed into products useful to humans. Substances extracted from kelp appear in many products in the form of carageenan, algin, alginate and agar.

Kelp Life Cycle

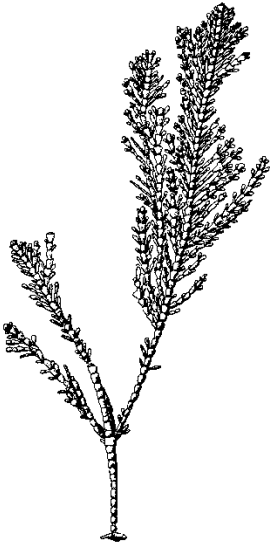
Most large seaweeds you see along the coast don't reproduce with seeds. Instead, they produce spores, which grow into microscopic photosynthesizing organisms. These tiny male and female algae produce sperm and eggs, which join and grow into the familiar large forms of kelp.

Some kelps, such as the giant kelp along the California coast, live for several years, but others, such as our local bull kelp, reach full size in just one year. They weaken with the lack of sunlight during the short winter days. Storm waves tear at these kelps, pulling loose blades and even entire holdfasts, which wash up as beach wrack on the shore.

More About Seaweeds

What we call seaweeds are algae. Algae, once classified as plants, now belong to their own taxonomic groups. Kelp have no true roots, stems or leaves. The algae of the ocean are divided into red, green and brown algae depending on the pigments they contain, although they don't always appear red, green or brown. Kelps are brown algae.

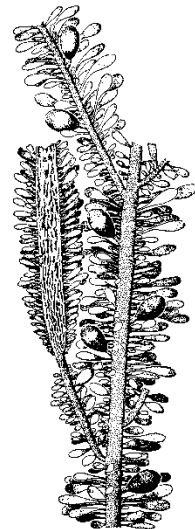
Seaweeds attach themselves to hard substrates such as rocks, buoys, pilings, shells and reefs on both exposed, wave-battered coasts and in quiet bays and lagoons. They grow as deep as 100 feet or more, limited by the depth at which they can still gather enough light to photosynthesize.



**Corraline alga,
a red alga**



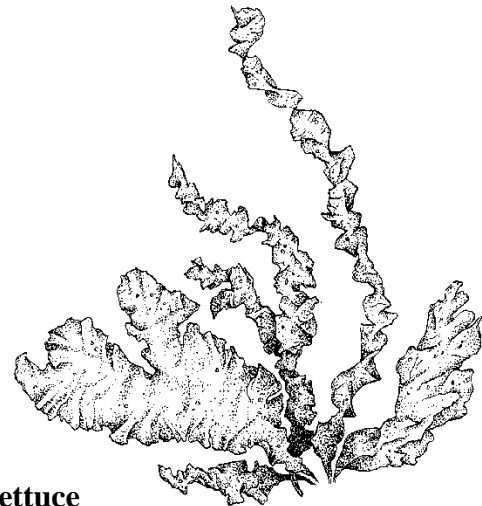
**Sea lettuce,
a green alga**



**Feather boa kelp,
A brown alga**

Vocabulary

- **adaptation** (*a-dap-TAY-shun*): a characteristic, such as a body part, color pattern or behavior, that helps an organism survive in its environment
- **alga** (*AL-guh*) [**plural: algae** (*AL-jee*)]: a member of certain phyla of the kingdom Protista (*pro-TIS-tuh*) (once considered plants). Most seaweeds are algae.
- **algin** (*AL-jinn*): an extract from brown algae used as an emulsifier and thickener in foods and other products
- **agar** (*AH-g'r*): an extract from a red alga used as a culture medium for microorganisms, for making soft casts such as dental impressions and as a thickener, sizing agent and preservative in some food products
- **blade**: the leaf-like part of a seaweed
- **canopy**: where the kelp reaches the water's surface; the top layer of the kelp forest
- **carrageenan** (*CAR-uh-GEEN-un*): an extract from a red alga commonly used as a thickening, jelling and stabilizing agent in foods and other products
- **haptera** (*HAP-t'r-ah*): the rootlike branches that make up the holdfast of a kelp
- **holdfast**: the structure of a kelp that anchors it to the seafloor
- **photosynthesis** (*foe-toe-SIN-theh-sis*): process by which green plants and some algae use the sun's energy to convert water and carbon dioxide into sugar and oxygen
- **pneumatocyst** (*new-MA-tuh-sist*): **the gas-filled float that buoys up a kelp**
- **spore**: any small organism or cell that can develop into a new individual
- **stipe**: the stemlike part of a kelp connecting the holdfast to the blades



Sea lettuce

Leaves to Roots

Lesson at a glance:

During this activity, your students will gain an understanding of the reasons why certain plants and animals choose specific habitats within a forest community.

Common Curriculum Goals and Benchmarks:

- 4.2** Interaction and Change: Living and non-living things undergo changes that involve force and energy.
 - 4.2L.1** Describe the interactions of organisms and the environment where they live.
- 5.1** Structure and Function: Living and non-living things are composed of related parts that function together to form systems.
 - 5.1L.1** Explain that organisms are composed of parts that function together to form a living system.
- 5.2** Interaction and Change: Force, energy, matter, and organisms interact within living and non-living systems.
 - 5.2L.1** Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.
- 6.1** Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.
- 6.2** Interaction and Change: The related parts within a system interact and change.
 - 6.2L.2** Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.

Materials:

For each pair of students:

- Clipboard
- Pencil
- Two or three sheets of unlined paper
- Hand lens (optional)
- Binoculars (optional)

Activity:

1. Explain to your students that when they come to the Aquarium, they will be learning about the kelp forest and some similarities and differences between this ocean community and a terrestrial forest community.
2. Pair students up and pass materials out to each pair.
3. Discuss observation techniques with students. Explain that they will be looking for organisms and considering the basic survival needs of each one. Review the basic needs of sun, water, food, air and shelter.
4. Take the class to an outside area with a variety of trees.
5. Ask each pair to choose a tree within hearing distance of you and sit next to it. Try to be sure several kinds of trees are represented.

The tree:

Ask the students to begin by drawing the tree. Next, ask them to write down where the tree gets the nutrients it needs to grow. Where does it make its food? How does it transport that energy to the rest of the plant?

The canopy:

Next, have them observe just the canopy of the tree. What animals are living here? Have them draw in the animals living in this part of the tree. Ask them to come up with two or more reasons why each animal lives in this part of the tree. What benefits do they receive from living here? What role does the canopy play in the life of the tree? What role does the canopy play in the life of the forest?

The trunk:

Ask students to closely observe the tree's trunk and draw in the animals living here. Again, ask them to think about the ways each animal benefits from living in this part of the tree. What role does the trunk play in the life of the tree? What role does the trunk play in the life of the forest?

The base of the tree:

Ask students to look around the base of the tree from the trunk to five to 10 feet away. Tell them to draw in the organisms (both plants and animals) they find in this area. Remind them to think about why each organism lives in this area.

The roots:

Last, ask your students to think about what the roots of their tree might look like and draw them in. Have them draw in organisms they think might live in the soil. Remind them of decomposers such as bacteria and fungi. What role do the roots play in the life of the tree? What role do the roots play in the life of the forest?

Note: Students may only find **evidence** of some of the animals that live in this forest community. For example, they may find a bird's nest, tracks or scat (animal droppings). If this happens, have them draw the animal they think left the evidence.

Also, be sure students understand it is not necessary to know the exact name of each animal or plant.

Summary:

Back in the classroom, discuss the students' observations.

Ask the students to share the types of animals they found in the top of the tree, on or in the trunk of the tree, at the base of the tree. What benefits does each animal receive by living there? Could it live in another location on the tree? Why or why not?

Explain to your students that they will be taking their knowledge of this terrestrial community to the Aquarium and comparing it to a kelp forest community.

Extensions:

- Have students enlarge their drawings into a mural. If there is a wide variety of trees depicted, the mural should represent a forest, including a canopy and understory, with plants of all different heights. Discuss what the plants can provide for each other. Do some plants need more sunlight than others? Are some plants living on other plants? What happens when a plant dies?
- Try this activity during different seasons. Do the animals and plants change? Ask the students to come up with reasons why different animals or different life stages of animals were found.
- Have your students study or draw the kelp forest community on their field trip. Which animals did they see near the holdfasts, stipes and blades? Why are they found there? What is the role of the holdfasts, stipes and blades?
- Have your students compare a temperate forest to a tropical forest. How do they differ? How are they similar?
- Discuss the impact humans have on a temperate forest, a tropical forest and a kelp forest.

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Kelp Words

Lesson at a glance:

In this activity students will become familiar with some of the vocabulary they will hear in the Forests Beneath the Sea lab program at the Aquarium.

ODE Science Content Standards:

SCIENCE

- **Fourth Grade:** 4.1 Structure and Function: Living and non-living things can be classified by their characteristics and properties.
- **Fifth Grade:** 5.1 Structure and Function: Living and non-living things are composed of related parts that function together to form systems.
- **Sixth Grade:** 6.1 Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.

OTHER CONTENT AREAS

Nonfiction reading and vocabulary

Ocean Literacy Principles:

5. THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

Materials:

- Kelp Background Information
- Kelp Forest Vocabulary
- Kelp Words Crossword

Background information:

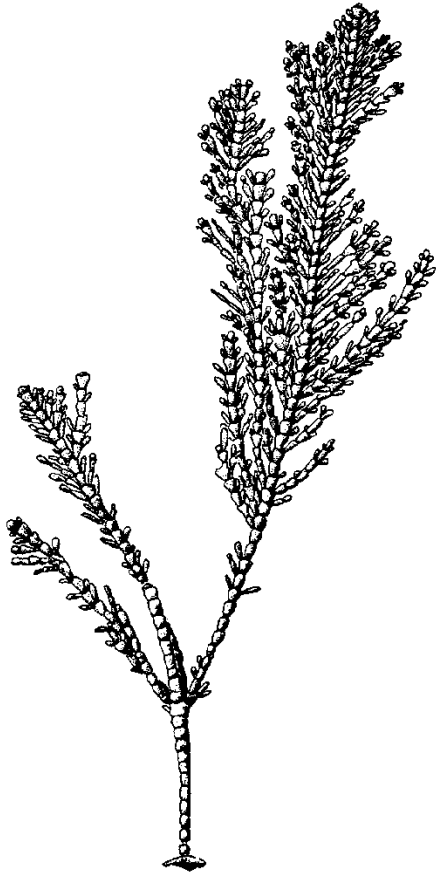
A terrestrial forest is made up of trees, each with roots, a trunk, branches and leaves. A marine kelp forest is made up of various seaweeds, many of which appear to have a similar structure and function as trees. Many kelp plants have a holdfast, which can be compared to the roots of a tree; a stipe in place of a trunk; and blades that act like the leaves of a tree.

While most students are probably familiar with the basic anatomy of a tree, few will probably have had the opportunity to learn about kelp. With a basic introduction to some of the words used to talk about kelp, students will be better prepared to examine these structures and understand how some of the kelp forest residents survive in their environment.

Activity:

1. Give your students a copy of the **Kelp Background Information** sheet included in your packet.
2. Ask the students read the entire information sheet once without stopping.
3. Next, have them read it again and write down a list of words they are unfamiliar with.
4. Have the students look up the words on their list in the dictionary or give them a copy of the **Vocabulary** list included in your packet.
5. Give your students each a copy of the **Kelp Crossword puzzle** to complete.

Kelp Words Vocabulary List



algae

blades

canopy

carrageenan

haptera

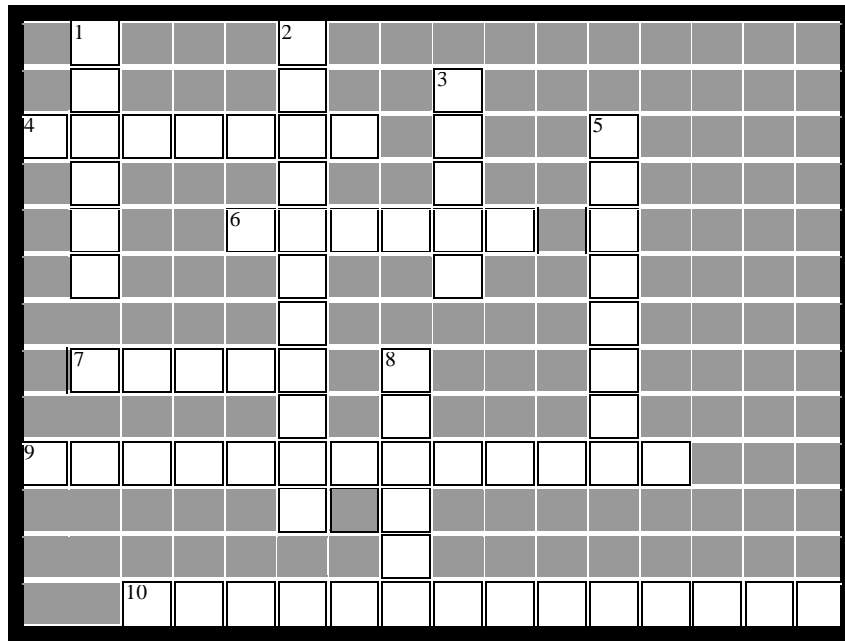
holdfast

photosynthesis

pneumatocyst

spores

stipe

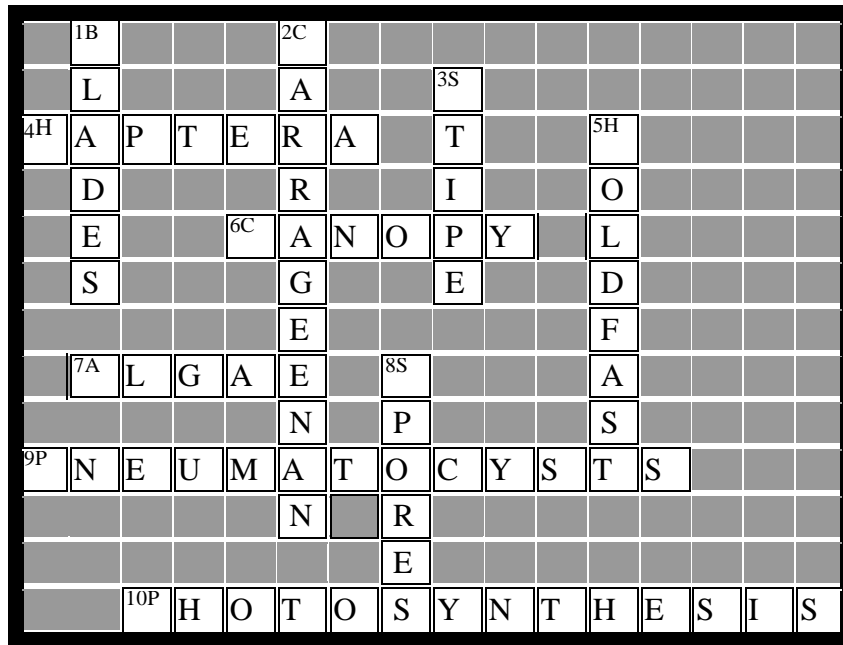


ACROSS

DOWN

- 4. The root-like branches that make up the holdfast.
- 6. The top layer of a kelp forest made up of pneumatocysts and blades.
- 7. Another word for seaweeds.
- 9. Gas-filled floats that buoy up the kelp plant.
- 10. The process by which green plants and some algae use the sun's energy to convert water and carbon dioxide into sugar and oxygen.

- 1. Like the leaves of a tree, these collect sunlight for photosynthesis.
- 2. Substances extracted from kelp appear in many products in the form of agar, algin, alginate and this.
- 3. This part of a kelp plant is flexible and strong enough to bend with the waves but not break.
- 5. Although it looks like a root, this gathers no nutrients or water for the kelp plant.
- 8. Most large seaweeds found along the coast don't reproduce with seeds, they produce this, which grow into microscopic plants.



ACROSS

DOWN

- 4. Haptera
- 6. Canopy
- 7. Algae
- 9. Pneumatocysts
- 10. Photosynthesis

- 1. Blades
- 2. Carrageenan
- 3. Stipe
- 5. Holdfast
- 8. Spores

Kelp in Your Kitchen

Lesson at a glance:

Students will familiarize themselves with the various products that contain kelp extracts.

Ocean Literacy Principles:

Principle 6: The Ocean and humans are inextricably interconnected.

B: From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

G: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Materials:

For grocery store field trip:

- ❑ Transportation
- ❑ Notepads
- ❑ Pens/pencils

For classroom kelp product party:

- ❑ Products containing algin or carrageenan (list included in Background)
- ❑ Eating utensils, bowls, napkins etc.

Background:

The largest and most conspicuous seaweeds are a group called kelp. Kelp is related to the algae that grow in ponds and is a marine plant. Unlike land plants, algae have no roots, leaves or flowers. They have no means of carrying water or nutrients to their different parts. (See **Kelp Background Information** sheet for more information about kelp structure and life cycle.)

People have used seaweeds for thousands of years. We have eaten them, used them in make-up, fed them to our animals and used them as fertilizers. Today, harvesting kelp is a billion-dollar business. Over 450 species of algae are used for food, fertilizer, medicine or industry. Over 20 different kinds of kelp are regularly eaten. Kelp has as much vitamin C as lemons, is loaded with B vitamins, and contains lots of iodine and other trace elements.

Seaweed harvesting is a lot like wheat harvesting. Specially designed ships move slowly through the kelp beds, pushing cutting racks ahead of them. The kelp is gathered on conveyors and loaded onto the ship. Harvesters are allowed to cut only four feet below the surface. Since kelp is about 92 percent water, a lot of kelp must be harvested to make a small amount of gel or dried kelp.

Once collected, the kelp is unloaded, chopped, washed, cooked and purified. It may be dried (to add to soups or sauces), kept fresh (to be fried or pickled) or processed into the gel used in thickening and stabilizing agents.

Here in the United States, kelp is harvested primarily in California, to make into algin (*AL-gin*). One ton of harvested kelp produces about 44 pounds of algin. When algin is

added to water-based foods such as salad dressing or ice cream, the product becomes thicker and creamier. When algin is added to a cake mix, the cakes stay moist longer. Algin is also used to coat paper, print cloth, make dental impressions and make your aspirin dissolve more easily.

Another seaweed product is agar (*AH-gar*). Agar is a gelling agent found in red seaweeds. It is the medium on the bottom of petri dishes used to grow bacteria in scientific and medical labs. It can also be used in canning fish and thickening ice cream, cream cheese and jams.

Carrageenan (*CAR-ah-GEE-nun*) is a stabilizer made from red algae. It is used to thicken foods, particularly dairy products such as chocolate milk. It is one of the few additives capable of keeping the chocolate and the milk mixed together. Some fast food restaurants use carrageenan to keep their burger meat together. It is also added to many products, such as toothpaste, to create a shiny surface.

Products that contain kelp extracts:

Ice cream	Root beer	Velveeta cheese
Some medications	Paint	Instant breakfast
Frozen dinners	Pudding	Slim fast
Salad dressing	Paper	Sunny Delight (juice)
Cream cheese	Jam	Entenmann's cakes
Toothpaste	Chocolate milk	Jell-O flan
Cake mixes	Pet food	Sara Lee cheesecake
Make-up	Hostess cup cakes & fruit pies	Lucerne non-fat cottage cheese

Activity:

1. Begin by asking your students if they have ever eaten seaweed. Some students may have tried sushi, but probably aren't aware that kelp extracts are found in many products that they use every day.
2. Have your students try tasting a variety of dried seaweeds. Some students may find that they really like it! If you live near the coast, there is a variety of fresh seaweeds that can be collected and eaten, such as sea lettuce. Otherwise, dried seaweeds may be purchased at health food stores and Asian markets.
3. Discuss kelp harvesting and many of its uses throughout human history.
4. Show your class products that contain kelp extracts. Have them read the ingredient labels and look for the words "algin", "agar" and "carrageenan"

Grocery store field trip:

1. Divide students into groups and assign certain aisles (that you know contain products they'll be looking for) to each group.

2. Before each group begins their search, have them choose a time keeper and recorder for each group.
3. Hand out notepads and writing utensils to the recorders.
4. Each group will have twenty minutes in which to complete their product list.
5. Have groups reconvene at a pre-determined meeting place after twenty minutes.
6. Allow groups more time if necessary.

Back at school:

7. List all the products found by each group on the board.
8. Explain why kelp extracts are used in each of these products.
9. Discuss kelp harvesting and how it might impact the marine environment.

Kelp product party:

1. Purchase several products (see list above).
2. Display product and packaging so that students can look for the kelp extract ingredient on the package and make observations about the product.
3. Students should be able to touch and taste each product (provide separate containers for each product to be touched and tasted).
4. Have students record their observations.
5. Have students share their observations with the class.
6. Discuss why kelp extracts are used in certain products (ie. to thicken, to create a smoother texture, to gel ingredients together).
7. Discuss kelp harvesting and how it might impact the marine environment.

Extensions:

1. Make homemade ice cream and compare it to store bought ice cream. Store bought ice cream will be creamier. OR Buy Breyer's and Dreyer's ice creams. Dreyer's contains a kelp extract and Breyer's doesn't.

Kelp Pickles

This recipe requires only seaweed from the beach and ingredients from any grocery store—no special canning equipment or experience needed!

1. Gather firm, shiny bull kelp freshly washed up; it appears from time to time year round, and often after storms in the fall. For each quart of pickles you want to make, take about 15 inches of stipe (the long, stemlike part) from the thicker end; you'll need more inches if you take from the thinner end.
2. At home, rinse the kelp. Cut the stipe lengthwise or slice it crosswise and pack the pieces into jars.
3. To each jar add:
 - ½ teaspoon pickling spices
 - 1½ teaspoons salt
 - and any of the following:
 - 1 dill head
 - ¼ cup chopped or sliced onion
 - 1 garlic clove, sliced
 - 1 chile or a dash of cayenne
4. In a saucepan, boil 2½ cups of vinegar for each quart of pickles.
5. Fill the packed jars with hot vinegar and screw on the lids.
6. Let the jars cool, and keep for up to six weeks in the refrigerator. The more days they sit, the picklier they will taste.
7. If you want to store your kelp pickles longer, you can put them in canning jars and seal them; most general cookbooks will have instructions and further recipe ideas. More recipes are also available in *Sea Vegetables Harvesting Guide and Cookbook*, by Evelyn McConnaughey.