

Inland Voyage
Kelp Forest Habitat Program

A discovery-based program for K-12 grade

EDUCATOR'S GUIDE

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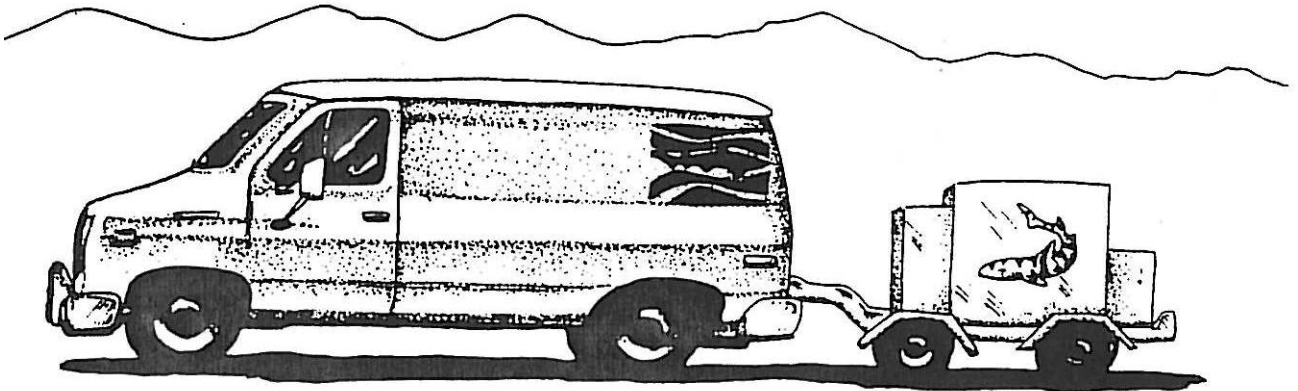
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Marine Science Institute's Educational Philosophy

As you plan an Inland Voyage Habitat Program with the Marine Science Institute, please consider how this opportunity fits within your overall instructional objective. What learning outcomes do you desire from the experience? What do you need MSI to make happen during the program? How well is the class positioned to move your desired outcomes toward a reality?

One strength of the Marine Science Institute's programs is their flexible role within the learning cycle. Is your group just beginning to generate interest in marine science (**engage**)? Or, are they "hooked" and, instead, are ready to actively experience, to form predictions and make observations (**explore**)? Have your students been developing understandings for some time, and are now ready to speak the language of marine science (**explain**)? Or, does your group have a mature understanding of marine science, perhaps including aspects that are far afield from the habitats covered in the Inland Voyage Habitat Program, and now the students are ready to relate that knowledge to their own backyard (**apply**)? Regardless of where you place your group on the learning cycle, there is a rich experience and a measurable success awaiting your program!

But...what you do before, during and after the MSI Inland Voyage Habitat Program will determine to a very large extent how strong of a partner the Inland Voyage Habitat Program will be in helping you meet your learning objectives.

INTRODUCTION TO THE INLAND VOYAGE HABITAT PROGRAM

This program guide is intended to further understanding of Marine Science Institute's Inland Voyage Habitat program curricula and program logistics. Through the use of this guide, teachers will know what to expect from our program and will gain a better understanding of the Kelp Forest habitat. The goal of the program is to instill in the students an appreciation for this diverse habitat and an understanding of how humans interact with the environment.

PROGRAM LOGISTICS

The Inland Voyage program is delivered to a school, library or camp by a vehicle called the Marine Science Mobile. Since this unit is both transport and life support for the marine organisms, the programs are presented outside and/or close to the Marine Science Mobile. We need an area accessible to the van that is large enough to set up a two-station program for up to 40 students. This area can be grassy or paved, and shade is always appreciated. If the area is separated from recess activities or any other traffic, the students will be more focused and attentive. Ultimately they will get more out of the experience if these factors are considered. Special arrangements due to weather conditions can be made if necessary.

There are seven different and exciting Inland Voyage programs that the Marine Science Institute offers to schools and groups. Five of these programs focus on marine habitats: Rocky Intertidal, Sandy Beach, Kelp Forest, Marshes and Mudflats, and Open Ocean. The two additional programs focus on groups of animals in or near the San Francisco Bay

Estuary: Bay Fish and Bay and Ocean Invertebrates. Activities for all of these programs are designed to be grade appropriate for Kindergarten to High School grade levels. The programs are all "hands-on" and discovery based, meaning that we give students the animals and equipment necessary to discover sensory or factual information about the animals and their habitats. Two instructors will guide the group through a fun-packed, fifty-minute exploration of these fascinating worlds. One class can experience more than one habitat on a given day, but due to van space and set-up needs, we can only offer two different types of programs per each visit to the school.

Our marine science instructors are specially trained to teach all ages with interesting and innovative methods that encourage interaction and problem solving. Our basic curriculum for each program is described in detail here and should prove to be quite challenging. However, we encourage you to tailor your program by telling us about a particular theme that your class has been studying and what level your class is at-engage, explore, explain, or apply. **Please fill out the student assessment form and return via mail or fax.**

PROGRAM LENGTH, GROUP SIZE, AND GRADE

Each program allows up to 40 students to participate and is 50 minutes in total length. The two instructors will give a five-minute introduction and then the class will divide into two groups, with each group participating in two 20-minute stations. To expedite this transition, we ask that the class be divided in half prior to our arrival. The program will wrap up with a brief five-minute closing discussion. We also schedule a ten-minute window between programs. The ten-minute intermission is essential to the well-being of the animals and enables staff to set-up for the next program.

ROLE OF ASSISTING ADULTS

In order to keep program costs at a minimum, we require the participation of at least two adults. The adults are encouraged to participate in various facets of the program such as group management, animal handling, and small group activities.

KELP FOREST HABITAT PROGRAM DESCRIPTION

During this 50-minute program, students will discover how live invertebrates interact to form a food web within the kelp forest environment. Students will also discover the wonders of this giant algae as well as various human uses of the kelp plant. A short introduction to the habitat will be given to your group as a whole. Then the students will be divided into two equal groups, and they will rotate between two stations, guided by MSI's Marine Educators. The "stations" will focus on a) invertebrates in the kelp forest and b) human uses of kelp. Students will see and touch live crabs, snails, sea stars, urchins, limpets, giant kelp and more.

Basic Ecological Concepts

Ecology is the study of the relationships between organisms and their environments. An ecologist asks questions. Where does this organism live? What characteristics make it particularly suited for that location? How does this organism get its food? What other organisms eat it? By asking questions such as these, some basic principles emerge. Understanding the following basic ecological concepts will help us appreciate the complexity of life residing in the various aquatic habitats covered in the Inland Voyage Habitat program.

Everything is connected to everything else!

Perhaps the easiest place to see interdependence in the environments is to look at food. All of the food on this planet is made available initially by plants through the process of photosynthesis. Herbivores are animals that depend directly on plants for food. Carnivores eat herbivores. Take away all the plants and there would be no more animals. Is it possible for a plant, then, to exist independently of all other organisms? No. Although it does not eat animals, a plant needs nutrients and is dependent on decomposers (bacteria and fungi) to break down dead organisms, thereby releasing these nutrients for use by the living plant.

Everything depends on something else!

All organisms are also dependent on factors in the physical environment. They must have a source of water. Animals must have oxygen to breathe. Plants must have sunlight to perform photosynthesis, so if there were no sun, there would be no life. You can probably think of many more examples of how organisms are interdependent on their environments.

Everything must go somewhere!

No object ever disappears completely from the face of the earth. It may be broken down into atoms and be used to build something else, but those atoms are still there. In this way, nature deals with waste recycling. Any plant or animal that does not become food for some animal becomes food for decomposers when it dies. Decomposers free the nutrients so they may be used again. Anything that cannot be decomposed must remain in the environment as it is. What are some examples of this kind of waste? The next time you throw something away, you might remember that there is no "away" to throw it to.

Earth's resources are limited!

How often do you run out of time to do what you want or need to do? Everyone knows that each day only has so much time in it, and that we have to be careful how we use it if we are going to accomplish everything we need to do. The earth's available resources are like time in that we have to be careful how we use them, or they might run out. There is only so much gold, so much petroleum, so much fresh water, so much food, and so much space. All organisms are limited by the availability of resources, but humans have a special opportunity and a special responsibility. Although a plant cannot make a decision to conserve clean water, humans can. To do this intelligently we must find out how much of each resource is available, and then we must monitor our use. We must also think about recycling. The earth can recycle its components naturally but humans must make special efforts to preserve the natural resources.

KELP FOREST ECOSYSTEM

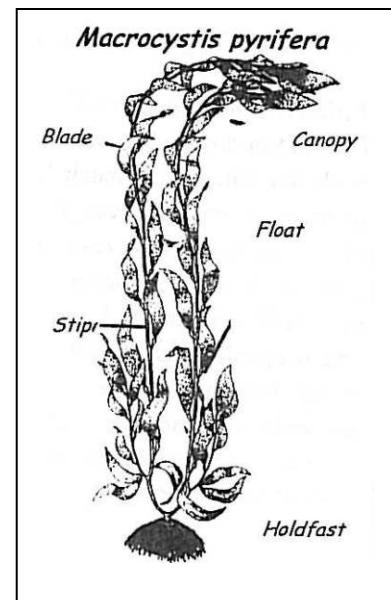
The kelp forest is the area close to the shore where dense forests of giant brown algae grow. The kelp forest is an important ecosystem because 1) it provides protection and food to a huge diversity of animals, 2) it is considered an edge community where land and sea interface creating an extremely productive area in the ocean environment and 3) it is harvested and used in many food and cosmetic products.

We are lucky here in California to have such a unique marine environment right in our own backyards. Kelp forests require specific environmental characteristics in order to grow and thrive. Kelp can only grow in nutrient rich, chilly (50-68 °F), offshore (35-100ft) environments with strong currents and a nice rocky bottom. Therefore, kelp is not found south of the Baja Peninsula in tropical or subtropical waters, but may be found again south of the equator along the temperate coasts of South America.

THE KELP PLANT

All kelp is a type of marine plant called algae. Algae are similar to, but simpler, than most land plants. Algae have no leaves, stems, roots, or flowers. For this reason, all algae are grouped into the Kingdom Protista. There are three different types of algae: green, red, and brown. Though all three types of algae occur in abundance along the California coast, particular species of brown algae are what make up the tall forests of kelp. The most common plant in the kelp forest is *Macrocystis pyrifera*, also known as giant kelp.

A kelp plant has three main components. These parts include the following: the holdfast, stipe, blade and float. The holdfast acts as an anchor for the kelp plant. One adult holdfast can harbor more than 500,000 sea creatures living within the root-like structure. The holdfast helps the plant withstand the pull and surge of currents and waves. The stipe is like the stem of the plant. It is not rigid like the stem of a terrestrial plant, but instead can bend with the waves without breaking. The blade of a kelp plant is the factory or workplace of the plant where most of the photosynthesis takes place (specifically in the chloroplasts). Photosynthesis is the process by which plants convert carbon dioxide and water to produce their own food, a simple sugar known as glucose. It is



important to note that oxygen is merely a byproduct of this complex chemical reaction just as it is with land plants. The float is an air bladder attached to the blade, which helps to keep the blades near the water's surface for sunlight. The gas in the air bladder is made by the kelp itself and not absorbed from the atmosphere.

The kelp plant has other adaptations that ensure its survival in the often turbulent nearshore waters. Some of these adaptations include the following:

- Wrinkled leathery blades, which increase the surface area of tissue exposed to the water and sun.
- Possession of extra efficient photosynthetic pigments.
- Ability to thrive as deep as 100 feet below the surface if the water is clear.
- Ability to grow more than 18 inches per day in optimal conditions.

Kelp has been harvested and used commercially since the early 1900's. Today, approximately 300,000 pounds of kelp are harvested annually in California. Algin, a derivative of kelp, forms the basis of this multi-million dollar industry. It is used in ice cream, gels, beer, dental molds and fertilizer. The algin helps make these products thicker, creamer and/or more stable over extreme differences in time or temperature. Kelp is harvested by large ships, which have blades similar to a lawn mower on the back of the ship. They trim off the top 3-6 feet of the canopy using these massive blades. Refer to "Is There Algae in Your House" on pages 11-13 for more information.

LIFE IN THE KELP FOREST

Kelp forests provide a habitat for entire communities of plants and animals. Over 200 species of plants and animals call the kelp forest home. The plant and animal communities of this near shore habitat rival rainforests and tropical coral reefs for species diversity and richness. The kelp plant itself is only the beginning of that diversity. The plants define the underwater forest much like the Redwoods define the forests of the California coastal ranges. Like a forest on land, a kelp forest can be divided into layers. You can find different kinds of animals in different layers. At the top of the kelp forest, many fish swim among the fronds. The top layer of a kelp forest, like that of a forest on land, is called the canopy. Marine mammals, young fish and seabirds spend time in this area. In the middle of the kelp forest, snails and other creatures crawl on the blades and stipe. At the bottom of the kelp forest, brittle stars, sea urchins and many other creatures live among the holdfast. The forest of underwater plants creates a physical barrier for the currents and waves passing through it. This in turn slows down the plankton drifting in the water, which helps to support a protected nursery and feeding area for young fish and invertebrates.

CLASSROOM ACTIVITIES IDEAS FOR KELP FOREST STUDIES

ACTIVITY #1: Kelp Forest Creature Feature

Objective:

The objective of this activity is to familiarize and excite students about the creatures that live in the Kelp Forest.

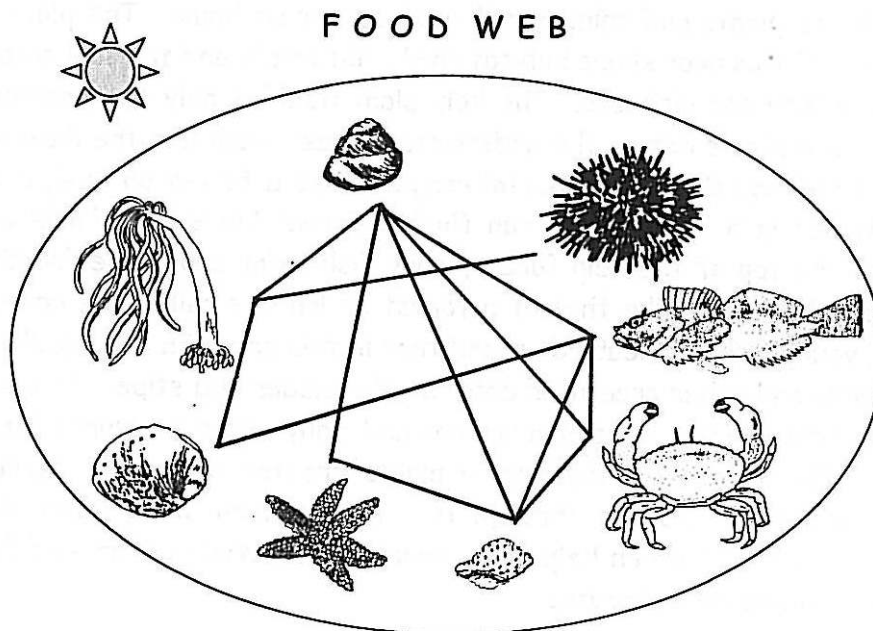
Procedure:

There are many possibilities for classroom activities using the "Creature Feature" information cards.

You may wish to conduct an "Each One - Teach One" with your students. Make enough copies of the creature information cards so that there is one featured animal per student when pages are cut apart. Let students choose a creature card randomly. Give students time to read the card or further research their chosen organism. Props and pictures are fun additions to this activity. Then, let the each one - teach one begin. Set up teaching "stations" around the room. Devise an organized way to have the students teach and learn from each other as they move between teaching stations.

Alternate activities could include:

1. The creation of a Kelp Forest food web using the creature information cards and poster boards.
2. Human Impact Activity: Have students pick a creature information card and research the impacts that humans have on that specific organism.





KELP FOREST CREATURE FEATURE



Purple Sea Urchin

Kingdom Animalia, Phylum Echinodermata

Description: Round shell made of calcium carbonate with short spines. Body is reddish to purple. Juveniles are pale green. They often burrow into rocks.

Food: They are herbivores that graze on algae.

Predators: Sea otters, fish and humans. Pollution is also a threat to urchins.

Fun Facts: Giant kelp is the preferred food of the sea urchin. They have tube feet, which catch the blades of kelp and pass food to their mouth. The mouth is located underneath their bodies.

Bat Star

Kingdom Animalia, Phylum Echinodermata

Description: This star has rough scaly skin and is webbed between the arms. The color varies from orange and red to brownish and purple. The bat star lacks spines.

Food: This sea star feeds on algae, surfgrass, and colonial tunicates.

Predators: Shorebirds and humans.

Fun Facts: Also commonly found in the Rocky Intertidal Community. A worm is known to live in the tube feet groves of this sea star.

Gumboot Chiton

Kingdom Animalia, Phylum Mollusca

Description: This is the largest chiton in the world. It grows to be 33 cm long. Its 8 plates are completely covered with a brick-red mantle, which has a rough texture.

Food: Herbivore, which feeds mainly on algae.

Predators: This animal does not have many enemies.

Fun Facts: The Gumboot chiton was once used as food by the West Coast Native Americans. Unlike most chitons this species does not cling tightly to rock surfaces.

Turban Snail

Kingdom Animalia, Phylum Mollusca

Description: Their shell can be brown or black with a spiral coiling shell. The snail's soft, muscular foot is black on the sides.

Food: It scrapes algae off rocks with a textured tongue, called a radula.

Predators: Shorebirds, fish, crabs, other snails, and humans.

Fun Facts: The black turban is one of the best known snails on the West Coast and has served in many field and lab investigations. These snails may live up to 25 years.

Hermit Crab

Kingdom Animalia, Phylum Arthropoda

Description: They have a long abdomen that is not flexed under the thorax. Instead it is completely unprotected. As a result hermit crabs must find a shell to live in to protect their soft bodies from predators.

Food: Diet is varied. Adults scavenge both plant materials and dead animal matter.

Predators: Birds, fish, octopi and sea otters.

Fun Facts: They seek protection in the shell of another animal, typically abandoned turban snail shells. Hermit crabs are not true crabs.

Decorator Crab

Kingdom Animalia, Phylum Arthropoda

Description: Resembles a spider in appearance. Camouflaged by a large population of creatures attached to the body by tiny hooks on the shell called setae. Long spindly legs. Sluggish.

Food: Omnivore. Eats algae, sponges, small crustaceans and some other invertebrates.

Predators: Fish and octopi

Fun facts: If a decorator crab is relocated, it replaces the old growth on its back and legs with species from the new environment as a disguise from prey and predators.

Rock Crab

Kingdom Animalia, Phylum Arthropoda

Description: Can grow to be 15 cm wide. Body wider side to side than front to back. The color is often lavender and red with red spots on claws and underneath body. Its claws have black tips.

Food: A scavenger and a predator who eats limpets and other tidepool creatures and kelp forest inhabitants.

Predators: Sea otters

Fun Facts: Is an important recreational and Native American food.

Kelp Crab

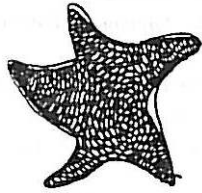
Kingdom Animalia, Phylum Arthropoda

Description: Shell has a smooth texture that is chestnut brown above and a reddish color below. There are four sharp spines on margin of body. Body and leg spines are for grasping seaweed. Adults may carry barnacles or other creatures on their shells.

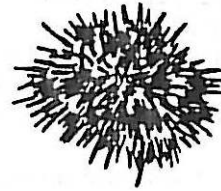
Food: Herbivore, which eats brown algae.

Predators: Sea otters

Fun Facts: Lives in low tide zone on rocky shores and during the winter migrates to deeper water to the kelp forest as they grow older.



Bat Star
Patiria miniata



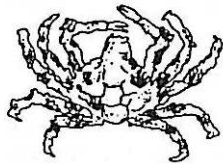
Purple Sea Urchin
Stonglyocentrotus purpuratus



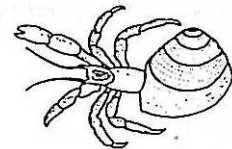
Turban Snail
Tegula funebris



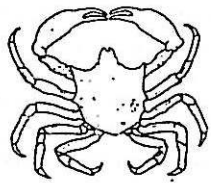
Gumboot chiton
Cryptochiton stelleri



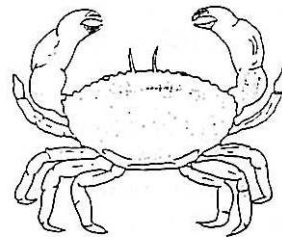
Decorator Crab
Loxorhynchus crispatus



Hermit Crab
Pagurus samuelis



Kelp Crab
Pugettia producta



Rock Crab
Cancer antonarius

ACTIVITY #2: Is There Algae in Your House?

Background:

Although fish and other seafood products make delicious, healthy meals for people all over the world, many American children would not mind if they never had to eat tuna casserole again. But they would mind if suddenly there were no more cheese and chocolate milk, peanut butter and pudding, and frozen desserts and fruit drinks. What could such different foods have in common? Along with hundreds of other common foods and household items, they contain the aquatic plants known as seaweed.

Many kinds of seaweed are edible and rich in vitamins and iodine. They are as common in many Asian Countries as green beans and carrots are in the United States. But until more people here develop a taste for sea vegetables, it is alginates, carrageenan, and beta carotene- seaweed derivatives that act as stabilizers, thickeners, and colorants - that end up on our dining room tables.

Seaweeds are not really weeds, but large forms of marine algae that grow in the coastal waters of many countries. They include thousands of species ranging from microscopic plants called phytoplankton to giant floating or anchored plants.

The three main groups of seaweed are brown, red and green algae, each providing important ingredient, for the manufacture of food and other products. Carrageenan is a generic term for compounds extracted from species of red algae. Carrageenans are used in stabilizing and gelling foods, cosmetics, pharmaceuticals, and industrial products. From brown algae come alginates. They make water-based products thicker, creamier, and more stable over extreme differences in temperature, pH, and time. For example, alginates prevent ice crystals from forming in ice cream. Beta-Carotene, a natural pigment derived from green algae, is used as a yellow-orange food coloring and may help prevent certain types of cancers.

These seaweed derivatives represent only a small part of the many living and nonliving products we derive from ocean plants, animals, minerals, and seawater. Together, they provide an important reason to protect the oceans.

Objective:

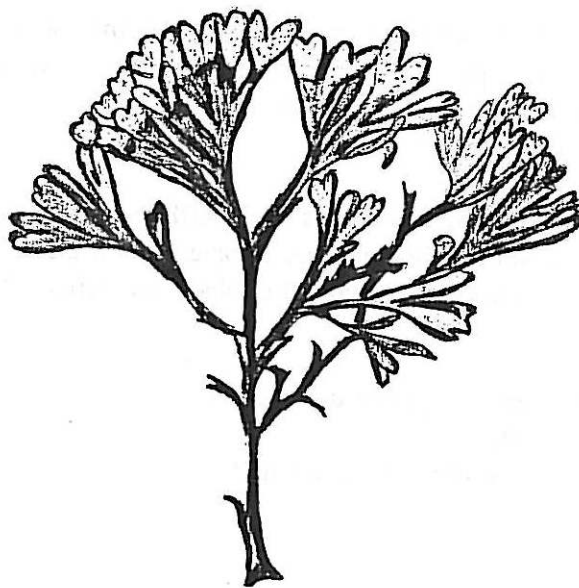
- Demonstrate that, although we sometimes can neither smell nor taste them, many ingredients in our foods and household products come from the sea.
- Investigate the foods you eat to determine what algae derivatives they contain.

You'll need:

- Collection of food items containing algae derivatives.
- Copies of the take-home page.
- Samples of Brown, Red, and Green algae (optional).

Procedure:

1. Look through your own kitchen and find a few food products that contain algae derivatives. Show these items to your class, without mentioning that they come at least partially from the sea. Ask students to guess what the foods have in common.
 2. Explain that each product contains algae in the form of seaweed, which is now used in many everyday foods and household items. Hold up one of the products that you brought in and show the students where they can find the nutrition label on the packaging. You may also choose to use photocopies or overheads of labels so students can see exactly where to look. Show students pictures or samples of brown, red, and green algae, from which ingredients in the foods on display are derived. To find these different type of seaweed, check an Asian supermarket or collect from the shoreline.
 3. Pass out copies of the take-home page and tell students to complete the survey of algae products in their homes. Remind them that not all brands of the products contain seaweed derivatives.
 4. Break the class into groups of three and give each group a few minutes to compare the results of its members' surveys.
 5. Ask if any of the groups found information on all of the foods listed on the take-home page. Do any of the foods contain two or more of the algae derivatives?
 6. Have students consider whether they would eat the whole seaweed plant, knowing now that they already eat algae extracts in many foods. Offer samples of dried, edible seaweed (nori, Kombu, Dulse, Kelp), if available, for students to smell and taste. Explain that algae are rich in vitamins and iodine. In Asian cultures especially, they are used as a wrapping to hold together rice, meat, and vegetables. Ask students what food they use to hold these ingredients together. What makes bread so much more readily available in the US than in Japan and other Asian countries?
- ** See next page for take home worksheet



Take Home Worksheet

Look for the following ingredients, which come from seaweed, in the foods you have in your house: carrageenan (derived from red algae), alginates (derived from brown algae), and beta-carotene (derived from green algae). Place the appropriate symbol for the ingredient listed on the food label next to the related food.

- * Carrageenan
- Alginate
- ♥ Beta carotene

PRODUCT CONTAINING ALGAE

Brownie mix	Mayonnaise
Cheese (yellow and orange)	Multiple vitamins
Chocolate milk	Pet food
Coffee creamer	Pudding
Cottage cheese	Relishes
Egg substitute	Salad dressing
Evaporated milk	Sauces and gravies
Frozen foods	Sour cream
Frozen yogurt	Toothpaste
Ice cream	Whipped topping
Infant formula	Whipping cream
Margarine	Yogurt

ACTIVITY #3: CREATIVE CLASSIFICATION

Objective:

To create an animal by using physical characteristics to categorize that animal in a classification system.

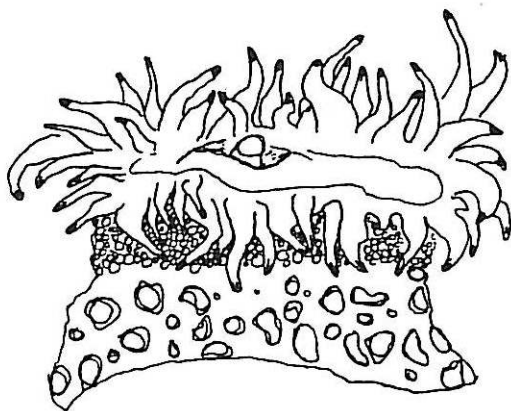
You will need

- Clay
- Paper
- Markers
- Reference materials

Procedure:

1. Each student chooses a phylum, class, order, and family in the animal kingdom after which to model their animal. Write down main characteristics. You may want to limit choices.
2. Separate clay into medium sized balls.
3. Give time to design an imaginary animal following the main characteristics of the chosen phylum, class, order and family.
4. Name animal with an original genus species name. Genus is a larger group for similar species. Species category is for organisms with similar structures.
5. Compare "new critters" to the others in the same families.
6. Discuss differences between animal characteristics, habitats, and diets that create *biodiversity*.

NOTE: You may change this lesson by asking the students to create an animal based on the physical parameters of a given habitat. They can use the same materials and assign their critter a genus & species name as before!



Anthopleura
Elegantissima

GLOSSARY

Adaptation: Modification of an organism in order to survive within its habitat.

Algae: Primitive aquatic plants that lack true stems, roots and leaves. They are in the Protist Kingdom.

Alginate: A derivative of brown algae.

Beta carotene: A derivative of green algae.

Biodiversity: The richness, abundance and variety of life across all trophic levels of which all ecological systems, including the planet earth, are comprised.

Blade: The leaf-like part of a seaweed.

Carageenan: A derivative of red algae.

Canopy: The top layer of the kelp forest where fronds float on the surface.

Edge Community: A productive area where land and sea interface. This community, because of its proximity to land, receives huge inputs of sediment, nutrients and freshwater, which in turn supports a diversity of plants and animals.

Herbivore: An animal which feeds on plant material.

Holdfast: The root-like part of a seaweed that anchors it to the seafloor.

Invertebrate: An animal without a backbone.

Omnivore: An organism that eats both plant and animal material.

Photosynthesis: The process used by plants to make food.

Stipe: The stem-like part of a kelp plant.

Scavenger: An organism that will eat just about anything. Scavengers usually include dead and decaying animal flesh in their diets.

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