Adaptations: Background Information & Pre and Post Activities

BACKGROUND INFORMATION

BASIC ECOLOGICAL CONCEPTS

Ecology is the study of the relationships between organisms and their environments. An ecologist asks questions like: Where does this organism live and 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 have emerged. Understanding the following basic ecological concepts help us appreciate the complexity of life residing in and around the Bay.

Everything is related to everything else

Perhaps the easiest place to see interdependence in the environment is to look at food. All food on this planet is essentially made by plants through the process of *photosynthesis. Herbivores* are animals, which depend directly on plants for food. *Carnivores* eat herbivores. Take away all of the plants and there would be no animals. Can a plant, then, exist independently of all other organisms? No. Although it doesn't eat, 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. You can probably think of many more examples of how organisms are dependent 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 by recycling. Any plant or animal that does not become food for some animal becomes food for decomposers, which free the nutrients to 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 really 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. 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 plants 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 budget 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.

FISH ADAPTATIONS

An adaptation is a physical characteristic or behavior that an animal evolves to become better suited to their environment. Taking a look at the external form or structure of a fish can tell us a great deal about where it lives and how it makes its living. The shape of the fish's body, the size and shape of its fins, the size and placement of its mouth, and the coloration of the fish each has a story to tell.

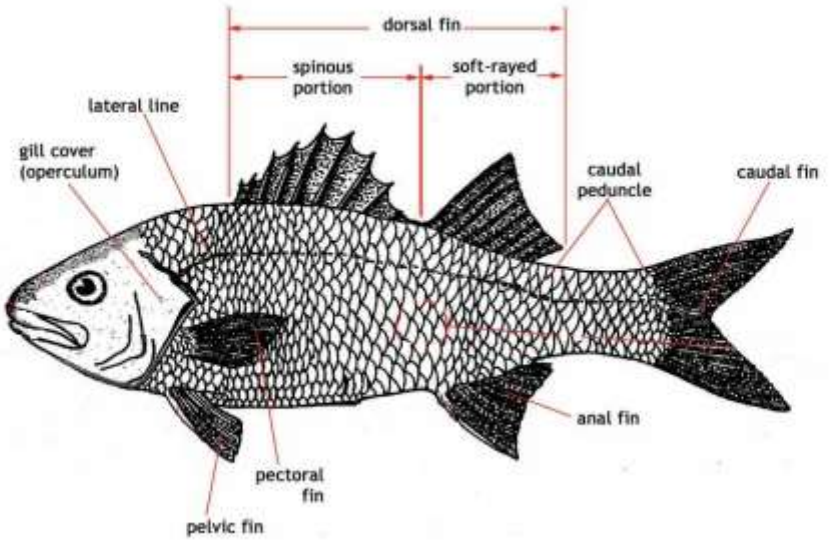
SHAPE

Fish that live on the bottom are often flat (or depressed), in order to conform to the surface on which they live. Mid-water fish are often laterally compressed for ease of movement through the grasses and crevices where they forage. Fish that live near the top of the water often have a long, slender, torpedo-shaped form in order to move quickly.

FOOD

Much can be learned about a fish's place in the food web by looking at its mouth. Fish like the California halibut, which are carnivorous and eat other fish, have big mouths and sharp teeth. Some fish, including anchovies, have sieve-like gill rakers (projections inside the gill openings that support the rakers) that filter plankton from the water. Bat rays, which feed on clams and other invertebrates, have a mouth positioned underneath their body, which is equipped with hard plates for crushing the shells of their prey.

EXTERNAL FISH ANATOMY



FINS

Fish have fins to help them move through the water. Each of the fins on their body has a different job. The tail fin, or caudal fin, gives the fish power and helps it move forward. The pectoral and pelvic fins help steer the fish, and in some fish help it move forwards and backwards. The anal and dorsal fins aid in stability, and in some cases they help propel the fish forward.

CAMOUFLAGE

Another external adaptation is the coloration fish have developed to avoid detection by their predators. The black bars of the leopard shark, for example, help disrupt the outline of its body. Many flatfish can change the color of their body to match that of the surface where they are living. Most fish display counter-shading, being dark on the top and light on the bottom. This helps them to blend in with the water and the bottom when seen from above and the sky when seen from below.

GILLS

Fish breathe by absorbing dissolved oxygen with their gills. Water taken in through the mouth moves over the gill filaments and passes out under the gill covers. Since less oxygen is present in water than in air, a fish's gills must be more efficient than lungs. Numerous filaments on the gill rakers (support for the filaments) are intended to increase the surface area of the gill, thus allowing greater intake of oxygen.

SENSORY ORGANS

Fish are able to perceive color. They do not have eyelids or tear producing glands. Nasal openings, or nares, can "smell" substances in the water. This is an especially important sense in salmon, which are thought to use nares to find their home spawning stream. Fish also have a sense of taste. Taste receptors are located in the mouth, head, and on other body surfaces. Feelers called barbels are located near the mouth. Fish can both hear and make sounds. The ear is entirely internal, and serves as a balance organ as well as an organ for hearing. Fish also sense their environment through the lateral lines which run the length of both sides of their body. The lateral line detects pressure changes in the water and enables the fish to register movement and distance.

Following is some information on specific Bay fish to help your students prepare for their program.

BOTTOM DWELLERS:

FLATFISH California Halibut, Diamond Turbot, Starry Flounder

Camouflage: Flatfish have an amazing ability to change color depending on the type of ground cover in the area. Thus, if a brown-colored flatfish living on a muddy bottom suddenly found itself in an area covered with white and brown rocks, its color would quickly change to a mottled white/brown appearance to blend in with its new surroundings!

Food: Eat mainly worms, tiny crabs, clams, or small fish.

Predators: Sharks, marine mammals, and humans.

Fun Fact: Flatfish actually begin life with one eye in the traditional position on each side of the head. Immediately after birth, however, one eye begins migrating across the head to lie next to the other eye on the opposite side. Because the fish lays flat on one side, having two eyes on one side is a distinct advantage in sighting both predators and prey!

SHARKS Leopard Shark, Brown Smoothhound

Descriptions: Leopard sharks are grey with heavy black bars and spots. Brown smoothhounds are a solid, coppery-brown color.

Food: Eat mainly small fish, shrimp, crabs, and clams.

Predators: Humans are the main predators of adult sharks.

Fun Facts: Sharks have no bones; their skeletons are made up of cartilage, like our noses. They can hear prey up to 1 mile away! Although they have generally poor eyesight, they have a great sense of contrast. Their eyes have a special layer that intensifies light so they can see their prey in near darkness.

Sharks have ancestors older than the dinosaurs by 200 million years! Although they have bad reputation, only 7 out of 365 species of sharks are truly dangerous to humans. Most are small, timid creatures more likely to flee from a swimmer than attack.

MIDDLE DWELLERS:

SURFPERCH Shiner Surfperch, Barred Surfperch

Description: Perch are normal fish shape (laterally compressed) and dwell in the mid-water zone. The barred surfperch has 6-10 dark vertical stripes on each side; the shiner surfperch has 2-3 faint yellow vertical stripes on each side.
Food: Worms, plankton, and sand crabs.
Predators: Birds, fish, and marine mammals.
Fun Facts: Their front-positioned mouth and small teeth allows them to eat smaller fish and other invertebrates. The lateral line is visible as a dark, thin strip running the length of sides. Used as "ears," these lines sense vibrations in the water.

TOP DWELLERS:

SMELT Topsmelt, Northern Anchovies

Description: Smelt are long, silvery and torpedo shape, with small mouths located at the front of their body. Anchovies are also long and silver, but have long lower jaws.
Food: Plankton and small crustaceans.
Predators: Many different birds and fishes. Also fished commercially and as sport.
Fun Fact: Top-dwelling fish school or group together when threatened by predators. This behavior possibly confuses the predator into believing that the school is one big fish!

BAY INVERTEBRATE ADAPTATIONS

PHYLUM PORIFERA (pore-bearing animals)

Red Beard Sponge *Microciona prolifera*
Description: Very bush-like in appearance, often mistaken for a plant, with numerous finger-like projections.
Food: Eats bacteria and dead plant and animal material (detritus) by absorbing these particles from the water as it flows through their bodies.

Predators: Sea slugs (nudibranchs).
Origin: Atlantic Ocean.
Fun Fact: A sponge may also be thought of as a mini "hotel" or "apartment complex," as it provides an excellent habitat for other living creatures. One sponge may contain hundreds of tiny organisms. Sea anemones may be present, along with spider crabs, which are able to camouflage within the sponge.

PHYLUM MOLLUSCA (soft-bodied animals)

Asian Clam *Potamocorbula amurensis*
Description: Shells are white, tan or yellow. One shell is larger than the other producing a distinct "overbite".
Food: Filter feed on plankton.
Predators: Diving birds, crabs, and bottom feeding fish.
Origin: China and Japan.
Fun Fact: This clam was introduced by the ballast of ships in 1986, and has since spread throughout the Estuary.

Green Mud Mussel *Musculista senhousia*
Description: Smooth, small (2 cm) dark shells with wavy brown and green bands.
Food: Filter feed on plankton and detritus.
Predators: Shorebirds and bottom feeding fishes.
Origin: Introduced from Japan with the Pacific oyster.
Fun Facts: Mussels are like tiny sewing machines! To keep from getting tossed about in the waves and/or tides, mussels form sticky threads, called byssal threads, and anchor themselves to the mud at the bottom of the Bay. These threads then harden and keep the animals from being swept away!

PHYLUM ANNELIDA (segmented worms)

Tube Worm *Asychis sp.*
Description: The brown, tubular structure made of mud is actually the home of the tube worm, while the long, red, slender creature inside is the worm itself.
Food: Because it eats much of the dead plant and animal material decomposing on the bottom, the tube worm can be thought of as one of the trash collectors of the Estuary! They are also great recyclers.
Predators: Bottom feeding fish and crabs.
Origin: Introduced to the Estuary with the Eastern oyster.
Fun Fact: The tube is constructed of both mud and mucus. To construct a tube, the worm eats mud and digests the living and dead microscopic plant and animal particles found inside. When finished, it secretes the mud back out again, mixed with sticky mucus, which flows down the sides of its body like a coat of paint on a house. Gradually, the tube is formed and the worm lives protected inside.

PHYLUM ARTHROPODA (jointed limbs)

Spider Crab *Pyromaia tubercula*

Description: Pear-shaped crab with long, spindle-like legs.
Food: Uses front claws to eat algae and detritus.
Predators: Bottom fish, sharks and shorebirds.
Origin: Native to the Pacific Coast.
Fun Facts: This crab gets both its nicknames for good reason. The first is obvious because it clearly looks like a spider! The second name comes through observing the fuzzy appearance of its shell and legs. The crab takes pieces of its surroundings and attaches it to its carapace and legs. This ensures camouflage and a meal when desired.

PHYLUM CNIDARIA (stinging nettle)

Orange Anemone *Diadumene cincta*

Description: Small, approximately 1 cm, flower-like body. usually pale pink or orange in color. Often found attached to the inside of empty shells, or on sponges.
Food: Zooplankton. Their flower-like appearance is due to several delicate tentacles flowing in and out of the solid tube-like column of its body. These tentacles are equipped with stinging cells which immobilize prey, then carry it down its tubular column and into its mouth.
Predators: Snails, seastars, sea slugs (nudibranchs).
Origin: Atlantic Ocean.
Fun Fact: If a sea anemone is left undisturbed for a few minutes, you can usually see its flowery tentacles appear.

PHYLUM CHORDATA

Solitary Tunicate or Sea Squirt *Mogula Manhattensis*

Description: Globular or "bag-shaped" body, usually translucent and yellowish in color
Food: Filter feed on plankton using two straw-like siphons to pull water in and out of its body.
Predators: Mainly sharks.
Origin: Atlantic Ocean.
Fun Fact: A tunicate's body is inflated with water. When a tunicate is gently squeezed, it will squirt out water like a fountain from one of its siphons; hence, its nickname!

SAN FRANCISCO BAY PINNIPED ADAPTATIONS

The word *pinniped* means feather-footed, and refers to the fact that this group of marine mammals have front and hind flippers. Animals that belong to this group are seals, sea lions and walruses.

Millions of years ago, the ancestors of these animals lived on land, as is the case with all marine mammals. The ancestors of Pinnipeds were probably weasels or bear-like animals that spent much time in the water and eventually adapted to the marine environment. There are three families of Pinnipeds:
Phocidae – "true" seals;
Ottariidae – eared seals; and
Odobenidae – walruses.

Phocids, or "true" seals, such as the harbor seal, are often seen in the waters of the San Francisco Bay. There are many species of Phocids, but you can always recognize them by their ears and flippers. True seals have ear holes, but no external ear flaps. They also have very small front flippers, which makes it very hard for them to maneuver on land. When on land, they are usually seen flopping around on their bellies. When swimming, they move their rear (foot) flippers back and forth like a fish's tail for power.

Family Otariidae includes sea lions and fur seals. Otariids that are local to the Bay area are the California sea lion and Northern fur seal. Otariids are easily recognized by their earflaps and flippers. Unlike phocids, they have external ear flaps and large front flippers that can rotate. These front flippers allow them to walk on land. In the water, they use these front flippers like oars to power their bodies.

The third family of pinnipeds are the walruses or odobenids. There are no local species of walruses. These animals have a combination of traits found in phocids and otariids including no external ear flaps but the ability to rotate their hind flippers. Both males and females of this group have tusks and vacuum-like mouths for sucking up shellfish from the ocean floor. All walruses are found in the Northern Atlantic and Pacific oceans.

Harbor Seal (Phoca vitulina)	
Description	Harbor seals have spotted coats in a variety of shades from silver-gray to black or dark brown. They reach 5-6 feet and weigh up to 370 pounds. Males are slightly larger and heavier than females.
Habitat/Range	In the northeast Pacific, they range from Alaska to Baja California, Mexico. They favor near-shore coastal waters and are often seen at sandy beaches, mudflats, bays, and estuaries. In California, the estimated population was 40,000 in 1997.

Behavior	Harbor seals spend about ½ of their time on land and ½ of their time in water, and sometimes even sleep in the water! They can dive to 1,500 feet for up to 40 minutes.
Food	Harbor seals are opportunistic feeders that eat sole, flounder, sculpin, hake, cod, herring, octopus and squid.
Fun Facts	In San Francisco Bay, many harbor seals are reddish in color. This may be caused by an accumulation of trace elements such as iron or selenium in the ocean.

California Sea Lion (Zalophus californianus)	
Description	Their color ranges from chocolate brown in males to lighter, golden brown in females. Males may reach 1,000 lbs. and seven feet in length. Females grow to 220 lbs. and up to six feet in length. At around five years of age, males develop a bony bump on the top of their skull called a sagittal crest.
Habitat/Range	California sea lions are found from Vancouver Island, British Columbia to the southern tip of Baja California, Mexico.
Behavior	California sea lions are very social animals, and groups often rest closely packed together at favored haul-out sites on land, or float together on the ocean's surface in "rafts."
Food	California sea lions are opportunistic eaters, feeding on squid, octopus, herring, rockfish, mackerel, and small sharks.
Fun Facts	During the breeding season, males patrol their territories and bark almost continuously.

SAN FRANCISCO BAY CETACEAN ADAPTATIONS

The word *cetacean* comes from the Latin word "cetus" for whale. Animals that belong to this group are whales, dolphins and porpoises. Millions of years ago, the ancestors of these animals lived on land, as is the case with all marine mammals. The ancestors of Cetaceans were probably small dogs that were more closely related to hippos, and went into the ocean about 60 million years ago. Over time, their front legs turned into paddle-shaped flippers. Also, they lost their back legs and their tails grew larger and widened to form their "fluke." They developed a thick layer of fat used to keep warm in the cold ocean water. Furthermore, their skulls elongated and eventually their nostrils shifted to the top and back of their head to make breathing on the ocean's surface easier. There are two suborders of cetaceans:

Odontoceti – toothed whales; and
Mysticeti - baleen whales.

Odontocetes are rarely seen in the waters of the San Francisco Bay because of the shallow nature of the estuary. Members of this group include killer whales and common dolphins. Odontocetes are easily recognized because they have teeth! They also have just one opening at their blowhole. There are over 73 species of odontocetes worldwide. Toothed whales tend to be social animals and are often found living in groups. They also have the special ability to detect objects in their environment through echolocation. They produce sounds waves in the air passages in their head, which is then projected in front of them like radar. These sound waves bounce off of solid objects and return to them so that the animals are able to get a "picture" of what is around them. Many odontocetes use this special ability to find, and possibly stun, prey.

Dolphins, porpoises and toothed whales all belong to the Odontocete suborder. Therefore, dolphins and porpoises can all be considered small whales. However, dolphins and porpoises differ in the type of teeth that they have. Dolphins have sharp conical teeth, while porpoises have spade-shaped teeth. This trait is what scientists' use when classifying dolphins and porpoises. Also, dolphins tend to have a pointed beak and a curved dorsal fin, when compared to porpoises, but there are exceptions to this rule.

Members of the suborder Mysticeti include the grey whale and blue whale. Grey whales are occasionally seen in the San Francisco Bay. There are 11 species of Mysticetes in the world. Mysticetes are also known as baleen whales because they have hundreds of rows of baleen plates in their mouth instead of teeth. These baleen plates are made out of keratin (the same substance our fingernails). These plates are often shaped to look like brooms and act like filters to strain food from the water. Most baleen whales feed by taking gulps of water into their mouth and then force the water back through the baleen with their tongues. The food, such as plankton and small shrimp, are trapped in the baleen and get eaten. This group includes the largest mammal on earth, the blue whale. Baleen whales have two blowholes instead of one.

Baleen whales can be further divided into three groups based on their specific feeding strategy. The rorqual whales, such as blue whales, feed by trapping water in their mouths and raising their tongue, which forces the water through their baleen. All species in this group have throat pleats, which allow their throat to expand to hold this large amount of water. The second group are the skimmers, which includes right whales. These whales swim along the surface of the water with a gap in their mouth in front of their long baleen. Their food gets trapped in the baleen and the filtered water flows out through gaps on the side of their mouth. The third group of whales are the mud suckers, which has only one member, the gray whale. Gray whales feed on the amphipods that live in the benthic mud of shallow areas, such as the San Francisco Bay, by turning on their sides and slurping the mud through the sides of their mouth.

Gray Whale (Eschrichtius robustus)	
Description	Gray whales are medium sized whales, reaching up to 49 feet in length, with the females usually being larger than the males. They are gray with white patches, which mostly consist of areas where barnacles and lice have attached themselves to the whales. Gray whales have approximately 300 plates of cream-colored baleen hanging form their upper jaw. Their blows are usually columnar or bushy in shape.
Habitat/Range	Gray whales are found only in the Pacific Ocean due to hunting in the Atlantic Ocean during the 17th century. They are long migrators. Some groups swim from the northern parts of Alaska to Baja Mexico yearly! The current population estimate is 26,000.
Behavior	Gray whales are generally coastal animals, and frequently travel alone. Migrating whales breathe and dive in predictable patterns.
Food	They mostly feed on amphipods filtered from benthic sediment.
Fun Facts	Gray whales usually carry over 400 pounds of barnacles and whale lice.

Blue Whale (Balaenoptera musculus)	
Description	Blue whales are the largest animal inhabiting the earth, reaching a length of 110 feet in length and weighing up to 400,000 lbs. They are a mottled blue-gray color. Blue whales are long and streamlined and their dorsal fins are very small. Blue whales have over 800 plates of black baleen in their mouth. Their blow is very tall and columnar.
Habitat/Range	Blue whales have been found in every ocean and are usually found swimming individually or in small groups. About 2,000 blue whales live off the coast of California.
Behavior	Not much is known about the social structure of blue whales. They tend to travel alone or in small groups.
Food	Blue whales generally feed during the polar summers, when the waters around the Channel Islands, Monterey Bay, and the Farallon Islands are teeming with krill.
Fun Facts	Blue whales have the loudest voice in the animal kingdom. They emit low-frequency sounds that travel hundreds of miles.

Orca or **Killer Whale** *(Orcinus orca)*	
Description	Orcas have familiar black and white coloration. Male orcas reach 30 feet in length, weigh over 6 tons, and have a dorsal fin that can be up to 6 feet tall. Females grow to be 26 feet long, weigh about 4 tons, and have a 3-foot high dorsal fin. Orcas have 50 conical teeth, which classify them as a dolphin.
Habitat/Range	Orcas are found in all oceans of the world, but favor cool waters. Some orca populations remain local and others are transient and move over great distances.
Behavior	Orcas are very social and generally live in pods or groups of up to 50 individuals. Studies have shown that each pod has its own distinctive accent, and that because of this accent, members of the same pod can recognize each other.
Food	Resident populations of orcas eat primarily fish while transient populations of orcas primarily eat marine mammals.
Fun Facts	At birth, orcas are 7 feet long and weigh almost 400 pounds. Orcas are not endangered, with at least 180,000 individuals in the Antarctic waters alone!

PRE-VISIT ACTIVITIES

You may want to ask your librarian to set aside ecology or marine science books for your class, or ask students to bring books and magazines from home to share.

ANIMAL ADAPTATIONS

Have your class research and discuss how marine animals protect themselves from their predators or what adaptations they have to become better predators. Have the class team up in small groups and be responsible for researching one phylum. Within each group, each student can choose one animal from this phylum. They can use books or any other resources to put together a report.

SCIENTIFIC CLASSIFICATION

Demonstrate the meaning of scientific classification by having students categorize inanimate objects according to their own framework. You could use fruit, or something ordinary such as different kinds of nails (wood, standard, aluminum, galvanized, ringed, headless), to each small group. Have them categorize and then share their results with each other to start a general discussion on classification. Do we need it? Is any one type of classification better than another? Is there a benefit to sticking to one standardized system of classification?

CAMOUFLAGE CRITTERS

Discuss the concept of camouflage, its usefulness to an animal, and perhaps how it evolved Through natural selection. Have students draw an animal camouflaged for a particular environment (forest, meadow, stream bottom, etc.) Or, choose environments on the school grounds and create a critter (from paper, clay, pipe-cleaners, even raw vegetables!) that is camouflaged in those surroundings.

Activities/Curriculum links:

https://coast.noaa.gov/estuaries/curriculum/

POST-VISIT ACTIVITIES

ACTIVITY: Sandy Beach Invent an Invertebrate

Objective:

Students will create an imaginary sandy beach invertebrate. One, given the harsh conditions on a sandy beach, that can survive and thrive in such conditions with specific adaptations invented by the student.

Background:

The sandy shore is a tough environment in which to live. Think of the last time that you spent at the beach. What animals did you see living on or under the sand? Probably not too many. The beach is an ever shifting and changing environment. There is no place to attach or

hold on. Waves are constantly washing and moving sand. Birds visit frequently to get a tasty meal with their probing beaks. Tides move the pounding waves and water up and down the beach. For these reasons, sun, air exposure, sand abrasion, predation, and the search and/or competition for food are all challenges that animals need to face to be able to survive in or on the beach.

You'll need:

- Markers, crayons, pens, pencils, and paper (for picture inventions)
- Clay, straws, pipe cleaners, paper cups, cardboard, etc. (for model inventions)

Procedure:

1. Initiate a brainstorming activity with the students to create a list of possible problems and stresses for life on a sandy beach. Make a visible list for the students. Introduce the word "adaptation".
2. Give each student or group of students materials with which to invent a sandy beach invertebrate. Students must be able to report a) where their animal lives on the sandy beach b) the problems the animal might face and c) the adaptations that the animal has in order to cope with the previously stated problems.

ACTIVITY: Creative Classification

Objective:

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

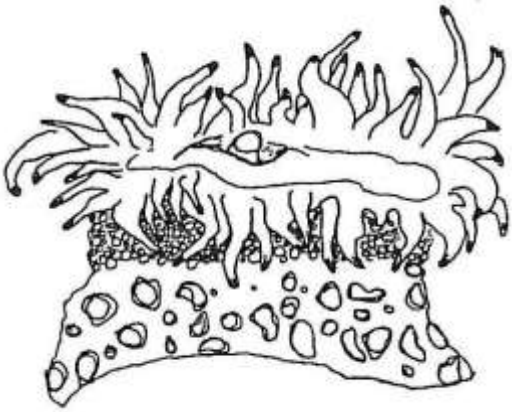
You will need

- Clay
- Paper
- Markers

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

WRITING THANK YOU LETTERS

Write letters to the instructors and/or your class sponsor to tell them about the trip. When we receive letters and pictures back from the kids our instructors remember what a thrill it is to be teachers. The sponsors also enjoy getting direct feedback from the class and teacher to reinforce that they are making a difference for kids learning science. Please include the day, date and time of your trip so we can try to remember your group a little better.

2. Choose a Champion (Grades 5-6)

Objective: To understand the function of an adaptation and that there are many ways to solve a problem.

During the program students learn about the environment of the bay and some of the different ways that organisms have adapted to the bay's physical challenges. In this homework activity, students in teams of 2 or 3 are to be assigned a particular challenge, and asked to research 3 different ways that different organisms had responded to the challenge either in form, process, or by use of a system. They are to prepare three simple reference cards on 8.5 x 11 inch cardstock. Each card is to have the challenge, organism name, a diagram or image of the organism, and notes explaining how the organism's adaptation (its features or behavior) met the challenge. Team names should be on the back of the cards.

When students return to class all the cards will be shuffled and pinned up on a wall, and everyone will be given sticky notes or colored circles with which to vote for the 2 most successful organisms. Students should make a personal mark on their "stickies" so that if they change their mind during the voting they can switch their vote. When the votes are tallied the class will discuss why these organisms were thought to be the most successful.

Here are just a few examples of physical challenges that organisms have adapted to that you might assign to the students:

- resisting pressure from the weight of water
- adjusting buoyancy
- living in mud
- hiding from predators
- collecting food without moving
- detecting prey
- resisting cold
- getting around in the dark.

Activities/Curriculum links:

https://coast.noaa.gov/estuaries/curriculum/