



Cabrillo Marine Aquarium Lesson Plan

Grade Level: Second through Fourth Grades

Title: Life on the Rocks: A Lesson on Tidepool Adaptations

Objective: Students will learn about some amazing ocean animals that live in the tidepool. They will also learn about their unique adaptations that help them survive on the rocky shore.

California Science Standards: 2nd: 2c, 2d, 4c, 4g 3rd: 3a, 3b, 5b, 5d, 5e
4th: 2b, 3a, 3b, 6a, 6f

Time to Complete: 50 minutes

Materials Provided by CMA Ocean Discovery Kits: *Worksheet: Which Creatures Live in the Tidepool?*, Invertebrate Specimens (sea star, limpet snail, barnacle, urchin spines, sea anemone, octopus), Posters, Books, and Habitat & Ocean DVD's

Materials Provided by Teacher: Drawing paper and markers, pictures & books of tidepool animals

Vocabulary: Tidepools, adapt, tides, high tide, low tide, predators, prey, exoskeleton, suction foot, tube feet, tentacles, camouflage, spines, algae, environment, habitat

Lesson Background and Outline: Read & Discuss with Your Students

Have you ever noticed how the water in the ocean moves away from the beach and then back again? If you build a sandcastle on the damp sand at low **tide**, by high tide it will have washed away. There are usually two **high tides** and two **low tides** every day. When there are rocks at the edge of the ocean you will often find pools of water left there at low tide. Many fascinating creatures live in these pools. There are sea stars, barnacles, urchins, anemones, sea snails, and even the occasional, colorful octopus. The waves that cover the pool at high tide bring water and food for these creatures, but when the tide starts going out again, it takes most of the water with it. The water that is left is heated by the sun, and some pools dry out completely. The creatures that live in the tidepools have to **adapt** to avoid being washed away by the waves, dried out in the sun, or being eaten by **predators**. Some sea creatures, like the barnacle, have a hard shell called an **exoskeleton**. The shell protects it from predators and allows it to store food and water, which keeps it alive even if the tidepool dries out completely. Others, like the sea snail fasten itself onto the rocks with a sticky, **suction foot** so it won't get washed away. On the other hand, the sea star has hundreds of tiny, **tube feet** on the underside of each arm to help it attach to the rocks in the pounding surf. The sea anemone adapts to

its tidepool **environment** by disguising itself as a harmless flower or plant, similar in color and appearance to other marine plants. But the sea anemone is a **predatory** animal and uses its stinging **tentacles** to capture passing **prey**, like a passing fish or a shrimp. The octopus has exceptional **camouflage** capabilities for hunting **prey** and hiding from predators. They can change their shape and color patterns within seconds to match their surrounding environment. The octopus can also squirt clouds of black ink to confuse and dull the senses of unwelcome predators. The sea urchin is covered with hundreds of sharp **spines** that serve as an **adaptation** to discourage many potential predators. As a plant-eater, the sea urchin has adapted to rocky tidepools by developing five sharp, teeth to grind away at the rocks and dig a home to protect itself from the pounding surf.

Activity 1:

Have students work on the Worksheet: Which Creatures Live in the Tidepool?

- Make copies of the worksheet handout and distribute to your students.
- When the sheet is completed, discuss which animals make the tidepool their home and which animals live in another habitat.

**Answer Key: Anemone, Urchin, Sea star, Clam, Barnacle, Snail, Octopus, Crab
(the Gull is a visitor, not a resident)**

Activity 2:

Ask students to answer the following questions about tidepool animal adaptations.

- Barnacles have (**exoskeletons**, bones or borrowed shells) which protect them from predators.
- Sea stars fasten themselves onto the rocks when the tide goes out with (legs, **tube feet**, or hooks) so that they can't be washed away.
- The octopus protects itself from predators by (hissing like a snake, throwing out its guts, or **squirting ink into the water**).
- The sea urchin has (three, four, or **five**) sharp teeth which it uses to dig a home for itself in the rock.
- The sea anemone looks like a marine plant, but it is actually a predatory animal, with stinging tentacles to capture passing (predators, people, or **prey**).

Extensions: Take a Trip to the Tidepools at Low Tide

- Check out the Tide Chart at Cabrillo Marine Aquarium's website link <http://www.protides.com/california/364/>
- LessonSnips <http://www.lessonsnips.com>
- Doheny State Beach Interpretive Programs <http://www.dohenystatebeach.org>
- A Guide to the Side of the Sea: A Teacher's Guide for Field Trips to Rocky Intertidal Areas <http://www.parks.ca.gov/>



Cabrillo Marine Aquarium Lesson Plan

Grade Level: Sixth and Seventh Grades & High School / 9th-12th Grades

Title: **It Takes All Kinds: A Lesson on the Invertebrates of the Sea**

Objective: Students will explore invertebrate diversity and learn about five major invertebrate phyla (groups): Annelida, Cnidaria, Mollusca, Echinodermata, and Arthropoda

California Science Standards: **6th:** 5c, 5d, 5e, 7c, 7d, 7e **7th:** 3a, 3b, 7c, 7d, 7e
Grades 9-12: Biology/Life Sciences

Time to Complete: 50 minutes

Materials Provided by CMA Ocean Discovery Kits: *Graphic: Invertebrate Cut-out Cards*, Invertebrate Specimens, Posters, Books, and Habitat & Ocean DVD's

Materials Provided by Teacher: scissors & copies of *Graphic: Invertebrate Cut-out Cards*

Vocabulary: Invertebrate, phyla, Annelida, Cnidaria, Mollusca, Echinodermata, Arthropoda, terrestrial, aquatic, parasites, segmented, jet propulsion, filter-feeding, byssal threads, radiate, water-vascular system, tube feet, respiration, herbivory, arachnids, subphylum, Crustacea, exoskeleton, abdomen, thorax, antennae, digestive system, reproductive system, appendages, plankton, free-floating, tentacles, nematocysts, carnivorous, toxin

Lesson Background:

Although many people think of animals as only those that have backbones such as fish, birds, amphibians, reptiles, and mammals, over 95% of the world's animals are invertebrates which lack backbones. Invertebrates are included in every animal phylum and although they all share the characteristic of not having a backbone, there is tremendous invertebrate diversity. They range from single-celled animals to highly intelligent organisms such as octopuses. For the purpose of this activity, we will focus on these five invertebrate **phyla: Annelida, Cnidaria, Mollusca, Echinodermata, and Arthropoda.**

Many **invertebrates** have a soft body, like the sea jellies and worms. Others have a hard outer shell, like insects and crustaceans. There are many types of invertebrates. The most common invertebrates include the **annelids** or worms that are both **terrestrial** and **aquatic**. The spiny-skinned, marine **echinoderms** like the sea star and urchin are only found in the ocean. Another group of invertebrates are the **mollusks**, which includes snails, clams and squid. Next group includes the **arthropods** which are the most abundant group of animals

on the planet. Some examples are insects, crustaceans and spiders. Lastly, the **cnidarians** include some familiar animals like the sea jelly and sea anemone.

- Let us go over these 5 groups of invertebrates and their unique characteristics.

Annelids

There are about 12,000 species of annelids (“ringed” worms) known today, including earthworms and leeches. They can be found almost anywhere in the world. Annelids have **segmented** bodies that are divided into sections. They have well-developed internal organs. One common characteristic of annelids is that they do not have any limbs. Some annelids may have long bristles, while others have shorter bristles and seem smooth, like the earthworm. Most annelids are small, measuring fractions of an inch to several inches long, but the giant earthworm of Australia reaches lengths up to 3 m (10 ft). Some worms are considered **parasites**, in that they live inside another living organism.

Molluscs

Most mollusks have a basic body form that includes a head with sensory organs, a large soft mass, and a muscular foot. Some mollusks live on land, such as the garden snail and slug. Other mollusks are **aquatic**, like the oyster, mussel, clam, squid and octopus. Land-living mollusks move slowly on a flat sole called a foot, while many ocean living mollusks move or swim by **jet propulsion**. They propel themselves by ejecting water from their body. For example, the squid ejects water from a cavity within its body, and the scallop ejects water to move by clamping its shell closed. Other ocean-living mollusks, like mussels, attach themselves to rocks or other hard surfaces with **byssal threads**. Mollusks capture food in a variety of ways including **filter-feeding** like clams, scraping algae off rocks like limpets, and stunning prey with poison like cone snails.

Echinoderms

The phylum Echinodermata is comprised solely of marine species and includes sea stars, brittle stars, sand dollars, and sea urchins. Most echinoderms have arms or spines that **radiate** from the center of their body. The central body contains their organs, and their mouth for feeding. All echinoderms have a **water-vascular system** with fluid-filled **tube feet**, which serve a variety of functions including locomotion, feeding, and **respiration**. In most echinoderms, much of the respiration takes place across these tube feet. Echinoderms feed in a variety of ways including filter feeding, **herbivory**, and active predation.

Arthropods

The name "arthropod" may not sound familiar, but you probably know them; you may even have eaten one. This group of unique invertebrates includes crustaceans, **arachnids**, millipedes, and insects. The **subphylum Crustacea** is composed primarily of marine invertebrates like the crab, lobster and shrimp. Most have a hard **exoskeleton** which protects their body. Crustaceans have a head and a body trunk which is often further divided into a **thorax** and **abdomen**. The head has **antennae**, which are part of their sensory system. The abdomen includes the **digestive system** and **reproductive system**. The thorax

or abdomen also has **appendages**, such as legs, for crawling and swimming. Many crustaceans also have claws and hooked legs that help with locomotion and feeding. The barnacle may not look like a typical crustacean, but it uses its feathery legs to capture tiny **plankton** floating by.

Cnidarians

This class of invertebrates is found in aquatic or marine environments. The name Cnidaria comes from the Greek word “cnidos,” meaning stinging nettle. There are about 9,000 species of cnidaria, the most commonly known being the jellyfish, sea anemone, and coral. Cnidaria come in two different body forms: **free-floating** form such as the jellyfish, and the stationary-form such as the sea anemone. Both forms consist of a body surrounded by **tentacles** with stinging cells, called **nematocysts**. The body has a single opening or mouth, for taking in food and expelling waste. Cnidaria lack many specialized organs. They are brainless, heartless & spineless creatures. Yet, they are **carnivorous** and prey on organisms ranging in size from small plankton to larger animals such as sea stars, sea slugs, and fish. They capture prey using their tentacles. When prey comes in contact with the tentacles, harpoon-like stingers inject a **toxin** into the prey, paralyzing or killing it. Humans frequently come in contact with cnidarians, particularly jellyfish. Most toxins from their tentacles do little more than irritate human skin. However, with some forms of Cnidaria, such as the sea wasp, a sting can be deadly.

Procedure:

- Divide the class into groups of 2 or 3 students.
- Pass out the *Graphic: Invertebrate Cut-out Cards* (1 for each group)
- Have students cut the cards and phylum headers, shuffle them and stack the cards in a deck.
- Have students take turns drawing one card at a time and have them place it below the correct phylum (group) header.
- After each turn of the card, have each group discuss the animal traits that scientists might use to help classify it in one of the five phyla.

Example: This earthworm is an annelid because it has segmentation and a soft body.

Lesson Wrap-Up & Discussion:

Discuss with your students which animals belong in the correct phyla and the physical traits that helped them classify each invertebrate group. Give clues as to which animals fit in specific categories. As you give clues, students can rearrange their guesses if needed. Encourage students to take notes during this exercise. Some animals are more obvious than others, but there is only one phylum an animal can be classified under in its adult form.

Answer Key:

CNIDARIA	ANNELIDA	MOLLUSCA	ARTHROPODA	ECHINODERMATA
moon jelly	polychaete worm	periwinkle snail	hermit crab	ochre seastar
sea anemones	sea mouse	bent-nose clam	sand crab	sand dollar
sea nettle	planktonic polychaete worm	octopus	spiny lobster	sea urchin
sea pansy	scale worm	mussels	striped shore crab	brittle star
gorgonian sea fan		market squid	rock crab	bat star
		purple olive snail	acorn barnacles	basket star
			brine shrimp	

Lesson Extensions: Additional Review

Hold up one picture card at a time from among those provided, covering the name of the animal with your fingers. Ask students to name: the animal, the group, the characteristics of that group, and other animals in the same group.

Further Student Exploration: Marine Invertebrate Report

As a class assignment or as a homework report, have students research one particular marine invertebrate discussed in this lesson. Have the student report on its special adaptations, physical features, diet, predators, conservation status, etc. Have students create posters that showcase their invertebrate and give short presentations to explain their posters.

References:

- Kidport: Life in the Sea
<http://ww.kidport.com/RefLib/Science/Animals/Annelids.htm>
- Animal Kingdom: All about the World of Animals
<http://animalkingdom.net/category/invertebrates/>
- The Shape of Life Library
<http://shapeoflife.org/phyla>
- Missouri Botanical Garden: Marine Ecosystems
<http://www.mbgnet.net/>



Cabrillo Marine Aquarium Lesson Plan

Grade Level: Kindergarten and First Grade

Title: Color in Science: A Lesson on Camouflage

Objective: Students will be able to define camouflage and explain how it helps animals survive in their habitats. Students will experiment with colors and textures and learn that camouflage is an important adaptation that helps the octopus avoid getting caught by predators

California Science Standards: **K:** 2a, 2b, 2c, 4a-e **1st:** 2a, 2b, 2c, 4a, 4d, 4e

Time to Complete: 50 minutes

Vocabulary: Strategies, prey, predators, camouflage, blend, invertebrate, tentacles, suction cups, heart, gills, lifespan, solitary, mating, species, oxygen, plankton, carnivorous, jet propulsion, adapt, regenerate

Time to Complete: 50 minutes

Materials Provided by CMA Ocean Discovery Kits: *Worksheet: Octopus Coloring Sheet, Worksheet: Parts of an Octopus, Graphic: Parts of an Octopus Answer Key, Octopus Specimen, Posters, Books, and Habitat & Ocean DVD's*

Materials Provided by Teacher: Art materials for ocean scene (sand, rocks, shells, etc.), scissors, crayons, markers, paint, construction paper

Lesson Background:

Animals in the wild have a difficult life. They have to hunt for their food, instead of buying it in a supermarket like we do! In turn, they are hunted by other animals. So they need to have special **strategies** to help them sneak up on their **prey** and also to hide from their **predators**. One of the methods they use is **camouflage**. Camouflage means to disguise or hide and animals have many different ways to camouflage themselves. For example, decorator crabs attach anemones, coral and anything else they can find to their shells. Other animals use the color, shape or pattern on their bodies to **blend** into the background where they are not easily seen. Some insects, like the stick insects, look exactly like the leaves or branches they sit on. A zebra's stripes make it difficult for predators to pick out individual animals to chase. Other animals change their color: Arctic foxes are brown in the summer when they can hide among the trees, but white in the winter so that they are not easily seen against the snow. Probably one of the best

animals at camouflaging is the octopus. Not only can the octopus change its color very quickly, but it also changes its texture and the patterns on its skin so that it matches the texture and patterns of the ocean floor. The octopus also hides itself in a cloud of black ink, which it releases if a predator gets too close. This gives it time to make its escape. As well as hiding the octopus from the predator, the ink also contains a chemical that can affect the predator's sense of smell.

Lesson Outline:

Activity 1: Camouflage the Octopus

- Before this lesson, paint a large underwater ocean scene, about the size of a large classroom bulletin board.
- Add shells, sand & cut-outs of seaweed and rocks to make it look realistic.
- Give each student an *Octopus Coloring Sheet* and tell them to carefully color the octopus, so that it blends into the underwater ocean painting.
- Be sure to supply students w/ paints, rocks, crayons, sand & any other materials you have used in the ocean scene so that they can pick certain materials to decorate their octopus.
- When they have finished, have each student paste their octopus onto the ocean scene where they think it best blends in.
- As a class, vote which octopus is hidden the best.

Activity 2: All About the Octopus (read aloud to class)

Octopuses are **invertebrates**, they have no bones in their bodies. This aspect allows them to go through very tight places and squeeze between rocks or live in spaces in which other animals cannot reach them. The only hard parts in octopuses are their beaks. They use their beaks to bite and also to release poisonous saliva that is used to subdue their prey. They also have very good eyesight and can spot their prey and choose the best place to grab it.

Octopus comes from a Greek word which means eight-legged or eight-footed and the reason for this is that its foot is divided into eight **tentacles**. These tentacles are like long flexible arms. On each tentacle, there are two rows of suckers or **suction cups**, which allow the octopus to hold on tight to anything it catches. These suction cups also allow the octopus to identify and taste what it is touching. Octopuses are shaped like a bag or their heads look similar to bulbs. Octopuses have three hearts. Two **hearts** pump blood to the **gills** and one pumps blood through the body. The color of their blood is bluish-green. Octopuses are known for their intelligence and their problem-solving skills. They are considered the most intelligent invertebrate and some scientists consider them even more intelligent than dogs.

Octopuses have a short **lifespan** of up to only five years. They are **solitary** animals. The male usually dies after a few months of **mating** with the female. The female will stay and watch over her eggs without ever leaving them from one to two months depending

on the **species**. She will not move even to feed herself. She will watch over the eggs and jet water over them to make sure that they get enough **oxygen** and are clean. The mother dies soon after the eggs hatch. The newly hatched octopuses spend their first weeks as ocean **plankton**, at the surface of the water. Then they gain weight and drop to the bottom.

There are approximately 300 species of octopus in the world. The largest octopus species is the giant Pacific octopus, which weighs anywhere from 30-100 pounds and has an arm span of about 14 feet. Octopuses can be found in every ocean in the world at different depths. Their bodies are usually smaller in warmer waters and larger in cold waters. They live in small, tight places in crevices between rocks or corals. They are **carnivorous** and eat fish, clams, lobsters, and crabs.

The predators of the octopus are moray eels, sharks, and marine mammals. Octopuses can crawl and swim. They can also use **jet propulsion** to provide themselves with greater speed to get away from their predators. Octopuses have two amazing aspects in their physical make-up to defend themselves against predators. First, octopuses have the ability to change the color of their skin and its texture, so that they camouflage themselves. This means that they change colors to **adapt** to the environment around them so that the predators do not see them. Second, if they are spotted, they are able to squirt and release black ink to confuse their predators who cannot see where they went or be able to smell them. Once they release the black ink they are able to swim away using the jet propulsion. If an octopus is caught, it can detach one of its arms to get away. The arms of an octopus can grow back again and **regenerate**.

Activity 3: All About the Octopus Quiz (*Test your students verbally*)

1. Octopuses are:

- a. Mollusks
- b. Cephalopods
- c. Invertebrates
- d. All of the above**

2. The number of hearts an octopus has is:

- a. One
- b. Two
- c. Three**
- d. Four

3. The number of tentacles an octopus has is:

- a. One
- b. Four
- c. Eight**
- d. Ten

4. and 5. Name two unique features about the self defense mechanism of the octopus (how it defends itself from predators or being seen by predators).

Octopuses are able to change the color and texture of their skin to camouflage themselves in order to blend in with their environment.

Octopuses can squirt and release black ink to confuse predators who cannot see where they went or be able to smell them

True or False:

- T** 6. The tentacles of octopuses regenerate or grow if they are cut off.
- F** 7. The tentacles of the octopus are a smooth surface that has nothing on them.
- F** 8. Octopuses are herbivores, meaning they only eat plants and vegetation.
- F** 9. Octopus can live up to 20 years.
- T** 10. The newly hatched octopus eggs spend their first weeks at the surface of the water as plankton.

Lesson Extensions: Role play

Procedure: Have students act out these sea scenarios.

(Teacher can describe scenario.)

- Waves crashing on a rock
- An octopus hiding
- A hermit crab moving into a new shell
- A sea anemone capturing a fish
- An octopus feeding on mollusks
- An octopus escaping from a predator
- A jelly floating with the current
- A crab walking sideways, defending itself with its claws

References:

- LessonSnips
<http://www.lessonsnips.com>
- A Guide to the Side of the Sea
http://www.parks.ca.gov/page_id=25535/