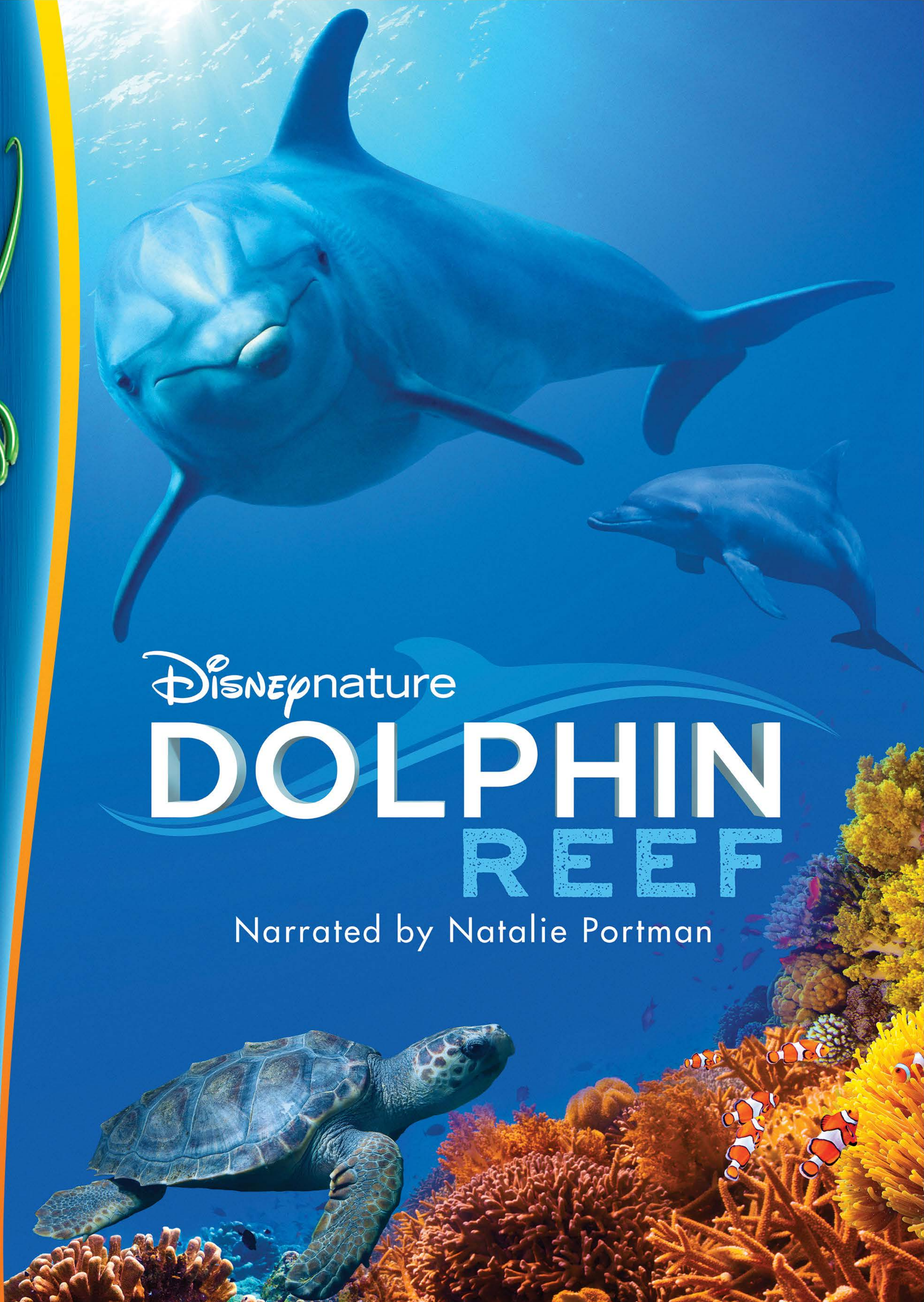
Disneynature



Disneynature

DOLPHIN REEF

Narrated by Natalie Portman

Educator's Guide

Grades 2-6

Created in Partnership with Disney's Animals, Science and Environment

Disneynature DOLPHIN REEF

Educator's Guide

Grades 2-6

In **DOLPHIN REEF**, Disneynature dives under the sea to frolic with some of the planet's most engaging animals: dolphins. Echo is a young bottlenose dolphin who can't quite decide if it's time to grow up and take on new responsibilities—or give in to his silly side and just have fun. Dolphin society is tricky, and the coral reef that Echo and his family call home depends on all of its inhabitants to keep it healthy. But with humpback whales, orcas, sea turtles and cuttlefish seemingly begging for his attention, Echo has a tough time resisting all that the ocean has to offer.

The Disneynature **DOLPHIN REEF** Educator's Guide includes multiple standards-aligned lessons and activities targeted to grades 2 through 6. The guide introduces students to a variety of topics, including:

- *Animal Behavior and Natural History*
- *Habitat and Ecosystems*
- *Biodiversity*
- *Earth's Systems*
- *Culture and the Arts*
- *Making a Positive Difference for Wildlife Worldwide*

Educator's Guide Objectives

- ✓ *Increase students' knowledge of the amazing animals and habitats of Earth's oceans through interactive, interdisciplinary and inquiry-based lessons.*
- ✓ *Enhance students' viewing of the Disneynature film **DOLPHIN REEF** and inspire an appreciation for the wildlife and wild places featured in the film.*
- ✓ *Promote life-long conservation values and STEAM-based skills through outdoor natural exploration and discovery.*
- ✓ *Empower you and your students to create positive changes for wildlife in your school, community and world.*

Disney.com/nature

Content provided by education experts at Disney's Animals, Science and Environment

Contents

Acknowledgments

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Allyson Atkins
Education Line of Business Manager
Disney's Animals, Science and Environment

Educational Standards

Standards Alignment	1 Dolphins, Sharks and Whales	2 Dolphins as Predators	3 Coral Reefs	4 Biomimicry	5 Small but Mighty	6 Sounds of the Sea
Common Core English Language Arts						
Reading				Key Ideas & Details: RI2.3; 3.4; 5.3		
	Craft & Stucture: RI2.4; 3.4; 4.4; 5.4; 6.4			Craft & Structure: RI2.4; 3.4; 4.5; 5.4; 5.5; 6.4		
				Integration of Knowledge and Ideas: RI4.7; 5.7; 6.7		
						Phonics & Word Recognition: RF2.3; RF3.3; RF4.3; RF5.3
						Fluency: RF2.4; RF3.4; RF4.4; RF5.4
Writing		Text Type & Purpose: W2.3; W3.3; W4.3; W5.3; W6.2b; Production & Distribution: W3.4; W4.4; W5.4; W6.4			Text Type & Purpose: W2.3; W3.3; W4.3; W5.3; W6.2b; Production & Distribution: W3.4; W4.4; W5.4; W6.4	
Next Generation Science Standards						
From Molecules to Organisms		4-LS1-1; LS1.A		4-LS1-1	4-LS1-1; LS1.A	4-LS1-1; 4-LS1-2; 5-LS1-1
Engineering Design				3-5-ETS1-1; 3-5-ETS1-2; 3-5EST1-3; MS-ETS1-1; MS-ETS1-2; MS-ETS1-3	K-2-ETS1-1; K-2-ETS1-2; 3-LS4-2; 3-LS4-3; LS4.C	
Biological Evolution	3-LS4-2; 3-LS4-3; LS4.C; MS-LS4-3; LS4.A	2-LS4-1; LS4.D	3-LS4-3; 3-LS4-4; LS2.C; LS4.C		2-LS4-1; MS-LS4-6; LS4.C	
Ecosystems		3-LS2-1; LS2.D; MS-LS2-1				
Earth & Human Activity			5-ESS3-1; MS-ESS3-3; MS-ESS3-4; MS-ESS3-5; ESS3.C; ESS3.D			
Energy						4-PS3-1; 4-PS3-2; MS-PS3-2
Waves & their Applications in Technologies						4-PS4-1; 4-PS4-3; MS-PS4-1; MS-PS4-2
Heredity Inheritance & Variations of Traits	3-LS3-1; 3-LS3-2; LS3.A; LS3.B					

Disneynature DOLPHIN REEF

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Numbers & Operations Fractions					4.NF.C.5; 4.NF.C.6; 4.NF.C.7; 5.NF.B.3; 5.NF.B.5A; 5.NF.B.6	
Operations & Algebraic Thinking			3.OA.A.1; 4.OA.1; 4.OA.2; 4.OA.5			
Measurement & Data			2.MD.1; 3.MD.B.4; 3.MD.C.6; 3.MD.C.7; 4.MD.A.1; 4.MD.A.2; 5.MD.A.1		4.MD.1	
Statistics & Probability			6.SP.B.4; 6.SP.B.5; 6.SP.B.5.B; 6.SP.B.5.D			
Ratios & Proportional Relationships					6.RP.A.1; 6.RP.A.3.A; 6.RP.A.3.D	
Social Studies Standards						
Dimension I				DI.2.3-5		
Dimension II Civics			D2.Civ.12.3-5; D2.Civ.13.3-5; D2.Civ.12.6-8	DII.Civ.9.3-5		
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National Arts Standards						
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Visual Arts Anchor 2		VA:Cr2.1.4a; VA:Cr2.1.5a; VA:Cr2.1.6a; VA:Cr2.2.4a; VA:Cr2.2.5a; VA:Cr2.2.6a	VA:Cr2.1.4a; VA:Cr2.1.5a; VA:Cr2.1.6a; VA:Cr2.2.4a; VA:Cr2.2.5a; VA:Cr2.2.6a; VA:Cr2.3.4a; VA:Cr2.3.5a; VA:Cr2.3.6a		VA:Cr2.1.4a; VA:Cr2.1.5a; VA:Cr2.1.6a; VA:Cr2.2.4a; VA:Cr2.2.5a; VA:Cr2.2.6a; VA:Cr2.3.4a; VA:Cr2.3.5a; VA:Cr2.3.6a	
Visual Arts Anchor 7			VA:Re7.1.4a; VA:Re.7.1.5a; VA:Re7.1.6a; VA:Re7.2.4a; VA:Re7.2.5a; VA:7.2.6a			
Media Arts Anchor 1		MA:Cr1.1.4; MA:Cr1.1.5; MA:Cr1.1.6			MA:Cr1.1.4; MA:Cr1.1.5; MA:Cr1.1.6	
Media Arts Anchor 2		MA: Cr2.1.4; MA:Cr2.1.5; MA:Cr2.1.6			MA: Cr2.1.4; MA:Cr2.1.5; MA:Cr2.1.6	

QUICK FACTS

Dolphins are...
Quick Learners & Very Adaptable!
Their large, complex brains allow them to problem-solve, quickly adapt to new situations and interpret their environment through sound waves using echolocation.

Dolphins are...
Pivotal Predators!
Populations of prey species are kept in balance due to the role dolphins play as predators within their ocean habitats.

Dolphins are...
Social!
They live within large social networks, but they're usually only seen in small groups at any given time. Dolphins use body language and a wide variety of vocalizations to communicate with each other.

Dolphins are...
Always Aware!
These high-energy animals are always on alert, keeping half their brain awake when sleeping to watch for danger.

Dolphins are...
At Real Risk!
Marine pollution, fishing nets, overfishing and climate change threaten dolphins and their coral reef habitats.

Disneynature DOLPHIN REEF

Dive Deeper into the World of Dolphins

Our Saltwater Planet

Although each of the five main oceans of the world have well-known names with which you may be familiar (Arctic, Atlantic, Indian, Pacific and Southern), the fact is they are all connected as one colossal body of water that covers most of our planet. The world's oceans are massive and the distance between shores of some continents can span over 9,000 miles (14,000 km). To cross the Atlantic Ocean, even the fastest ship in the world, which travels at 58 knots an hour (67 mph), would need 41 hours to complete the journey!

Oceans are key components to the health of our planet. They act like the heart of Earth's climate system. Just as the human heart circulates blood and regulates the body's temperature, oceans control the circulation of heat and moisture throughout the planet's climate system by moving heat and moisture via currents and winds. They also stabilize Earth's temperature by absorbing heat from the sun and transferring it to different parts of the climate system.

Most of the oceans are unvisited and unexplored by humans. Even now, vast areas both above and below the surface remain mysteries. Today, oceans are home to over 100 species of marine mammals, some 33,500 species of fish and hundreds of thousands of invertebrates that compete for resources in their ocean habitat. Every year, scientists are discovering new species in the world's oceans.

Dolphins are but one of the many species that make the enormous oceans their home. Through the lens of Disneynature, the story of Echo and his mom provide the inspiration to celebrate biodiversity and the richness of life under the sea.

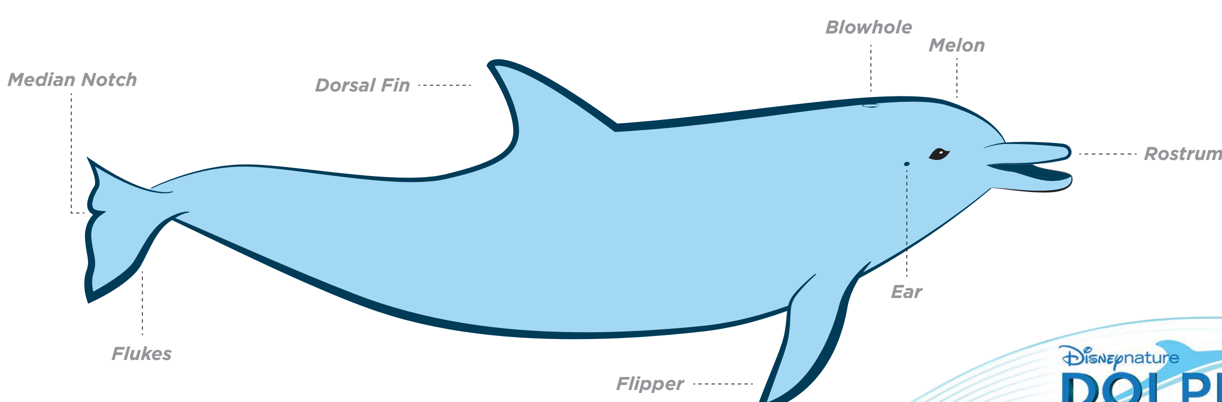
FUN FACT

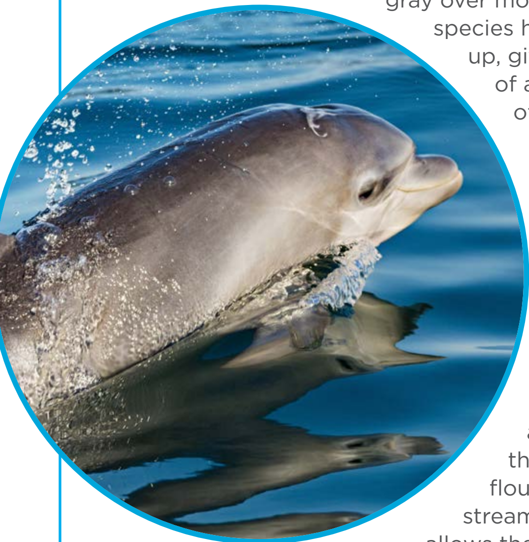
As recently as 2011, marine biologists identified a new species of dolphin. The Burrunan dolphin, found off the coast of southeastern Australia, was known to exist but it was not previously designated a distinct species from the bottlenose dolphins in that region.

Dolphin Design

There are about 35 species of dolphin (more or less depending on how you define distinct species). Taxonomically, dolphins are marine mammals belonging to the order Cetacea and are members of the family Delphinidae. Taxonomy is the classification of species, referring to biological ranks known as domain, kingdom, phylum, class, order, family, genus and species. But the dolphin family is much larger than the species many are familiar with as both orcas and pilot whales are also categorized in the dolphin family.

In Disneynature **DOLPHIN REEF**, Echo and his family are bottlenose dolphins, also members of Delphinidae. Bottlenose dolphins have a distinctive head shape which bulges around the forehead, and a streamlined body shape. Dolphins reside in all of the world's oceans and are typically found in shallower areas near coastlines. Various dolphin species range in size from about 5 to 33 feet (1.5–10 m) long, and weigh between 110 to 15,500 pounds (50–7,000 kg) with females typically smaller than males. Some species have distinct color blocks, but most are some shade of





gray over most of their bodies. Most species have a mouth that curves up, giving the impression of a fixed smile. A layer of blubber keeps their bodies warm in cool waters. They have lungs and must surface every few minutes to breathe air through a blowhole at the top of their head.

Like many marine mammals, dolphins have an external anatomy that helps them survive and flourish underwater. Their streamlined body shape allows them to swim with speed and agility, with the fastest species reaching up to 24 miles per hour (40 km/h). A dolphin's speed can be achieved due to their tail, or fluke, which they use to generate power. Dolphins also have front flippers which they use to help them steer, while the dorsal fin on their back provides stability. Compared to porpoises (which are also part of the order Cetacea), dolphins are more torpedo-shaped and have a longer rostrum.

FUN FACT **Dolphins surface to breathe through a blowhole approximately every 2 minutes, but can hold their breath for up to 12 minutes on deep dives.**

Above the rostrum, a dolphin's head has a distinctive bulge called a melon where fatty tissue is stored. The melon serves an important function. Like bats, dolphins use echolocation to explore their surroundings. Echolocation helps dolphins catch their prey, especially in dark or murky waters, similar to a flashlight, except with sound instead of light. Dolphins can direct a beam of sound out into the water from the melon. Sound waves bounce off nearby objects, creating an echo that transmits back through the dolphin's lower jaw to its ear and is detected by the brain. Based on the characteristics of the echo, the dolphin's brain can interpret the sound and determine what and where the object is.

Dolphins are carnivorous, getting energy and nutrients mostly from small fish and squid. They also eat some crustaceans like shrimp and crabs, as well as jellyfish and eels. Adults consume 15 to 30 pounds (7–14 kg) of seafood daily. Even though they have more teeth than any other mammal (88 to 200 teeth depending on the species), dolphins do not use their teeth for chewing. When a dolphin catches its prey, it will often swallow the meal whole. Some species will even rub or smack their prey until it is in small enough pieces to swallow. Although they find much of their food near the surface and spend most of their time in shallow water, they can dive up to 990 feet (300 m) and are capable of holding their breath up to 12 minutes.

Dolphins Together

Dolphins usually travel in groups ranging in size from a single individual to thousands of animals. These groups, or communities, can be comprised of various members from a nursery group with females and their calves, a mix of females and males who come together for mating or even all male bachelor groups. While in these social groups, dolphins are often playful, twisting and turning in the water, performing acrobatic jumps above the surface, and wake-surfing behind boats.

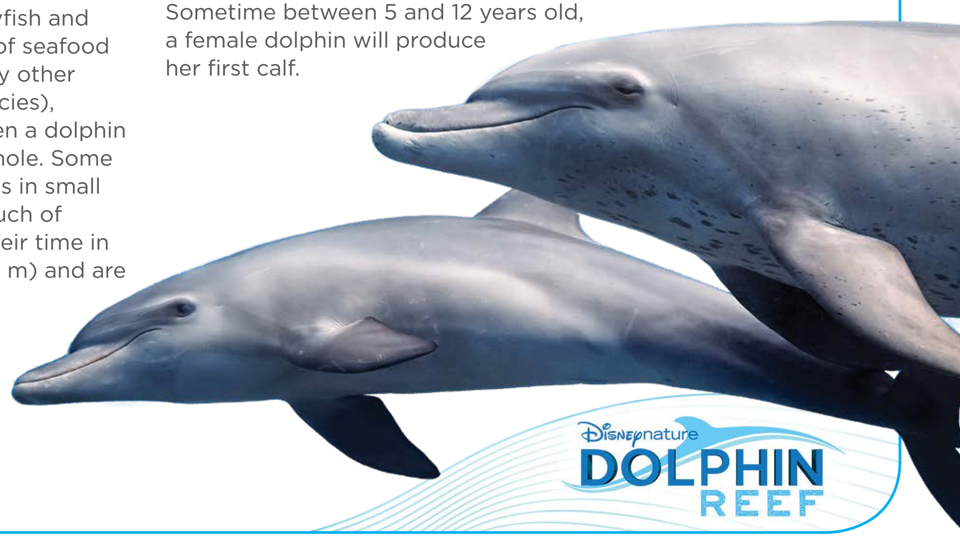
As part of their predation techniques, groups of dolphins can form hunting parties, helping each other chase and catch food in the ocean. A team of dolphins encircles a school of fish, herding them into a tight bait ball, then individuals will take turns darting into the mass to grab a meal. Or they may trap fish in shallow water to catch them. One population of bottlenose dolphins off the coast of Florida has been observed using a technique called mud-ringing. In this approach to feeding, one dolphin swims in a circle along the ocean floor, swishing its tail near the sand to create a ring of stirred-up mud which disorients and entraps the fish, forcing them to leap out of the water and into the waiting mouths of other dolphins.

When hunting alone, individual feeding strategies include knocking fish up above the surface of the water and stunning them to slow them down. Some dolphins have learned to unearth bottom-dwelling crustaceans using sea sponges for digging.

Dolphins also coordinate their behaviors for reasons other than feeding and playing. They have been known to work together to help support a dolphin at the surface that is injured or sick. When one bottlenose dolphin is hurt, others in its group may vocalize to alert others. For protection against sharks, dolphins may take turns ramming the predator repeatedly to drive it away. Other times dolphins may not be so cooperative. Young adult males may exhibit aggression toward each other, blowing bubbles and smacking their tails on the surface or scratching another individual with their teeth. This last example is known as raking, and although it does not cause deep lacerations, it can leave light scars that are visible for several weeks or months. These forms of aggressive behaviors establish dominance within the group.

Raising Young

Sometime between 5 and 12 years old, a female dolphin will produce her first calf.



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For bottlenose dolphins, gestation lasts one year and results in a single offspring. This cycle will repeat every two to five years. A dolphin calf is sustained only by its mother's milk for the first four months of life. At that point, the calf will start to eat fish, but will continue to nurse with its mother, typically until it is 12 to 18 months old.

Young dolphins stay with their mothers for at least three years, learning from them and other adult females about how to hunt and communicate. Communication occurs through a wide range of squeaks, clicks and whistles. Dolphins produce these sounds by pushing air back and forth between air sacs located below the blowhole. Clicking is primarily associated with investigating objects, such as prey. Whistles are used by individuals to identify themselves, similar to having a name, and will communicate their location to other members of the group. Some clicks and squeaks are too high in frequency for humans to hear, but using special acoustic instruments, called hydrophones, scientists have found that dolphins are most "talkative" while they are feeding or swimming very fast.

Mother dolphins utilize specific sound tactics specifically with their young. Whistles will be used back and forth between mother and calf to find one another when separated. As part of raising a calf, a mother dolphin will use loud pockets of sound called burst pulses to discipline their young. Tail slapping is also key in communication, as this typically warns others of danger, such as when a predator is nearby.

Dolphins Sharing the Ocean

Whales

Orcas are members of the dolphin family. They live in pods and communicate using a combination of sounds such as groans, clicks and whistles. Similar to dolphins, they use echolocation to search for food and they participate in cooperative hunting to trap their prey, which includes sea lions, seals, penguins, sharks, sea turtles, fish and smaller dolphins and whales. When a seal is out on the ice, orcas may synchronize their movements under the water to create a wave that knocks the seal off its perch and into their jaws. Orcas are powerful ocean predators, even attacking animals as large as humpback whales.

Humpback whales are another whale species named after the distinctive hump in front of their small dorsal fin. Each year, they migrate thousands of miles between their feeding and breeding grounds.

FUN FACT **Inside the jaws of humpback whales, baleen plates with wiry bristles let water pass through while food is trapped.**

Unlike orcas or other top predators in the ocean, humpback whales get their nourishment from small fish, krill and plankton, filtering these tiny nuggets of nutrition through baleen plates in their mouths.

During the feeding season, each humpback whale consumes between 4,000 and 6,000 pounds (1,814–2,722 kg) of food every day. One way to capture that much plankton or krill is to round up the prey using a technique called bubble-net feeding. To accomplish this, humpback whales will form a circle at about 50 feet (15 m) deep and expel air through their blowholes to form bubbles as they spiral up towards the surface. The resulting tube of bubbles traps the prey, allowing the whales to feed in large gulps.

In winter, humpback whales migrate towards warmer, tropical parts of the ocean to breed and give birth to their calves. Southern Hemisphere humpback whales, for example, tend to migrate towards areas off the coast of Africa, Australia, the southern Pacific Islands and South America during the breeding season. Females will give birth to a single calf after 11 to 12 months of gestation. The newborn whale is about 14 feet (4 m) long and learns to swim in less than an hour. Babies drink up to 100 pounds (45 kg) of milk each day from their mother and nurse for about 11 months.

Humpback whales regularly leap out of the water and splash down on their backs. This behavior, known as breaching, may help remove pests clinging to their skin. Or, it may be a form of play by the whales or a form of communication. Whatever the reason, it is exciting to see these massive animals interacting in their ocean home.

Sharks

Another group of marine animals that shares the ocean with dolphins are sharks. While sharks have commonly been portrayed as fearsome animals, these large fish possess remarkable adaptations that should be revered, not feared. Sharks have a unique skeletal structure made of flexible cartilage (which is what human noses and ears are made of!) They also have unique skin, called "dermal scales," that push the water down preventing drag when swimming. This allows them to move incredibly fast through the water. Sharks' teeth are kept strong and healthy with a natural fluoride. When one tooth falls out, a new sharp one emerges within a day. Sharks have excellent vision and sense of smell, and they can hear low frequency sounds emitted by injured prey, making them superb hunters.

With more than 500 species of sharks calling the ocean home, there is a lot of variation in size and diet. Larger sharks eat seals, sea lions, squids, rays and even other sharks. Smaller sharks stick to fish, crabs and other shellfish. An interesting exception is the whale shark—the largest fish in the sea—which feeds only on tiny fish and plankton. No matter what's on the menu, all sharks are carnivores and play the role of predator.

FUN FACT **Sharks usually swim along at about 1-3 mph (5 km/h), but some species can speed up to 60 mph (97 km/h)!**

The grey reef shark, for example, which can grow to be over 8 feet (2.5 m) long, hunts alone at night near the edge of coral reefs in search of crabs, fish and squid. During the day, grey reef sharks swim in schools, navigating other parts of the ocean where they might run into other species of sharks, like the tiger shark.

Many shark species are facing serious population declines due to overfishing, shark finning, habitat loss and incidental bycatch. Bycatch occurs when an unwanted fish, shark or other marine animal like a sea turtle, is caught during commercial fishing intended for a different species. Angel sharks, for example, are highly susceptible to bycatch in trawls because they reside on the ocean bottom. Human disturbance by habitat degradation and tourism are also possible threats to its preferred sandy nearshore habitat.

Rays

A cousin of the shark, the stingray, is one of several hundred different species of rays that live in oceans and in freshwater habitats. Rays use their "wings" and nose-like rostrum to sense prey and stir up the sand, uncovering clams, worms and crustaceans beneath the surface. Many rays have continuously growing dental plates instead of teeth, enabling them to crunch through the hard shells of clams and oysters. Unlike most fish, the upper jaw in rays is not fused into the skull, thereby allowing them to extend their mouth to create a suction for picking up prey items. Some rays, like the eagle ray, have pointed noses that are highly adapted for sensing and "rooting out" their preferred diet of clams and other invertebrates. Rays are slow-growing animals and reproduce slowly, which makes them especially vulnerable to overfishing—their depleted populations can take years or even decades to recover.

Dolphins on the Reef

Coral Reefs

While exploring different regions of their ocean habitat, dolphins encounter many other ocean animals. Some of the most unique species they share the ocean with are corals. Corals form the basis of an important marine ecosystem. An individual coral animal is called a polyp. Millions of coral polyps live together in colonies. Polyps in the colony use minerals from ocean water to build a hard base made of calcium carbonate which surrounds each polyp to protect it. If the polyp dies, a new polyp can attach and grow on top of the calcium carbonate left over from the dead polyps creating a solid structure that anchors new polyps. Over time, these groups of old and new coral polyps together form coral reefs.

Coral reefs support a huge diversity of marine life, acting like a combination grocery and home building supply store for the ocean. The reef ecosystem attracts everything from tiny algae to large sharks. Whether it is food or shelter they seek, many animals rely on coral reefs as safe and nurturing places. Fish, crabs, shrimp, oysters, seahorses and other sea life use corals for shelter from predators, hiding in the many crevices and spaces of the reef. Sponges, clams and anemones also make coral reefs their home. Sea turtles, octopuses, eels, rays and larger fish are attracted to reefs in search of this hidden prey.

The National Oceanic and Atmospheric Administration (NOAA) recently listed 22 coral species as "threatened" under the Endangered Species Act and two listed as endangered—ten times the number listed a decade ago. Coral reefs worldwide have declined significantly, with some individual species declining by 90% or more.Reduced growth and death of coral reefs are often the result of coastal development, changing climate and acidification of the ocean's delicate chemistry.

Sea Turtles

Sea turtles' streamlined bodies are remarkably adapted to ocean life. Their front legs have been modified into elongated flippers that they use for swimming, while their short, wide hind flippers act as rudders for steering. Their vision underwater is better than ours, and they have an acute sense of smell for locating food. Although they live in the ocean, they must come to the surface to breathe air. Sea turtles usually surface every 20 minutes to breathe, but during periods of rest they can stay underwater for several hours!

There are seven different species of sea turtles found throughout the oceans of the world: green, leatherback, loggerhead, hawksbill, Kemp's ridley, olive ridley and flatback. Different species of sea turtles like to eat different kinds of food. The diet of a green sea turtle depends on its age. Juveniles feed on jellyfish and worms. At the age of 2 or 3, these turtles expand their diet, feeding on jellyfish as well as algae and seagrasses. Loggerheads, on the other hand, are strictly carnivores. They have a massive beak that is strong enough to crush the shells of the mollusks and crustaceans they eat. Young loggerheads eat invertebrates like jellyfish and small crabs, while adults feed on larger, hard-shelled animals like horseshoe crabs, clams and other crunchy invertebrates. Sponges, anemones, squid and shrimp hiding in the crevices of coral reefs are not always safe from the beak-like jaws of the Hawksbill turtle.

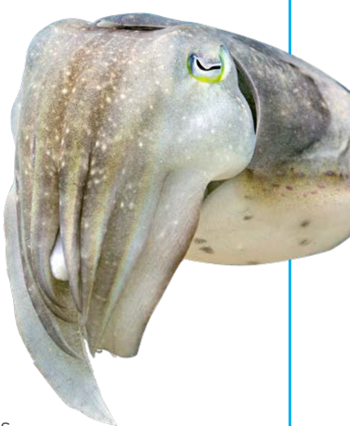
Six of the world's seven sea turtle species are found in the U.S, with the exception being the flatback. All six are protected under the Endangered Species Act. Climate change, death in fisheries bycatch and loss of nesting and foraging habitats are among the numerous threats that face sea turtles today.

Mantis Shrimp

Another inhabitant of the coral reef is the mantis shrimp. This colorful crustacean burrows into the coral, defending its territory with club-like appendages that can strike with incredible speed and force.
Mantis shrimp snack on other invertebrates, like crabs and mollusks, using their spring-loaded appendages to stun their prey with a punch so fast it causes a vacuum in the water (called cavitation) which can produce heat and light (called sonoluminescence).

To detect prey, the mantis shrimp primarily relies on an excellent sense of sight. Mantis shrimp eyes are located atop two stalks that can move independently. They possess a unique system of representing color in which each eye contains 12 specific color detectors that allow them to respond to potential prey faster than if color information had to be processed in the brain like most other animals. A mantis shrimp will hide in a coral crevice and ambush any prey that drifts within striking reach.

Cuttlefish



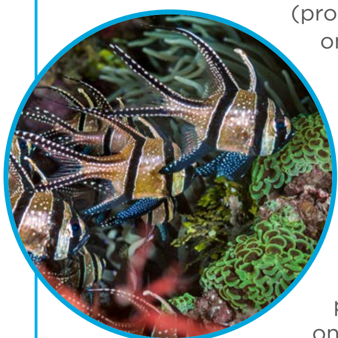
Cuttlefish are cephalopods related to octopuses and squid with differences in their anatomy. They have eight arms with rows of suckers as well as two tentacles and a beak-like mouth. Their skin contains chromatophores, special cells that allow rapid changes in appearance. A cuttlefish morphs how it looks, using different colors, shades, patterns and textures for camouflage, communication and hunting.

Inside its body, the cuttlebone is a porous structure made of calcium. By varying the amount of gas and liquid held in the holes of the cuttlebone, a cuttlefish can adjust its buoyancy to travel up and down.

Within the coral reef food chain, cuttlefish fall prey to sharks, rays, dolphins and large fish. They hunt for small shrimp, fish, and crabs along the ocean bottom, moving gracefully with an undulating movement. When frightened, the cuttlefish propels itself quickly using a squirt of water through its siphon. It can also produce an ink cloud that acts as a smokescreen enabling a quick escape.

Reef Fish and Other Animals

Adding to the palate of coral reefs themselves are the many species of reef fish that flash past in a spectrum of color. Yellow butterflyfish, orange clownfish and blue parrotfish spend the day floating around their reef restaurant. Nudibranchs, or sea slugs, provide brilliant designs of color and cuttlefish that can change shades add to the rainbow array. Even at night the reef is colorful, with species like bright red soldierfish and an assortment of sea urchins searching for a midnight snack.



A special type of algae, called zooxanthellae (pronounced zoh-uh-zan-thel-ee), grows on the coral polyps. Some animals, like parrotfish, feed on the coral polyps which contain zooxanthellae, scraping it off the reef with their beak-like mouths. Sea stars, such as the crown-of-thorns, and certain worms, snails and fish eat the coral itself.

While coral reefs cover not even two percent of the ocean floor, a full 25 percent of all ocean species depend on coral reefs. These are important ecosystems indeed!

Diving Birds

Above the surface of the ocean, many birds rely on coral reef habitats as places to feast, diving with precision into the water to catch a meal. The magnificent frigatebird spends most of its life flying over the ocean, feeding on fish, squid, turtles, crabs and jellyfish. With its long wings and forked tail, the magnificent frigatebird is an agile flier that can pluck prey out of the waves. Sometimes it chases down other seabirds and steals their catches. To attract a mate, the male frigatebird puffs up its bright orange throat sac and clacks its bill. Females lay their eggs in mangroves along the edge of the islands near coral reefs.

Another diving bird commonly found around coral reefs is the cormorant. To assist with deep dives under choppy waves, cormorants' bones are heavier than average. Unlike other bird species, cormorants do not have oil glands to keep their feathers waterproofed. After fishing for food, the weight of their wet wings is too much; cormorants spread their wings out to dry before flying again to continue the hunt or return to land.

Other seabirds have very light bodies designed to glide far and float easily, making it difficult for them to dive underwater. To solve this problem, they use speed. From great heights, they dive-bomb into the water, using velocity and a streamlined shape to propel themselves below the surface. Plunge-divers like the northern gannets will drop from as high as 130 feet (39.6 m), hitting the water at around 55 miles per hour (88.5 kph) when hunting for mollusks. Their slit-like nostrils can be closed off to prevent saltwater from entering, and air sacs under the skin help protect them from injury much like airbags in a car.

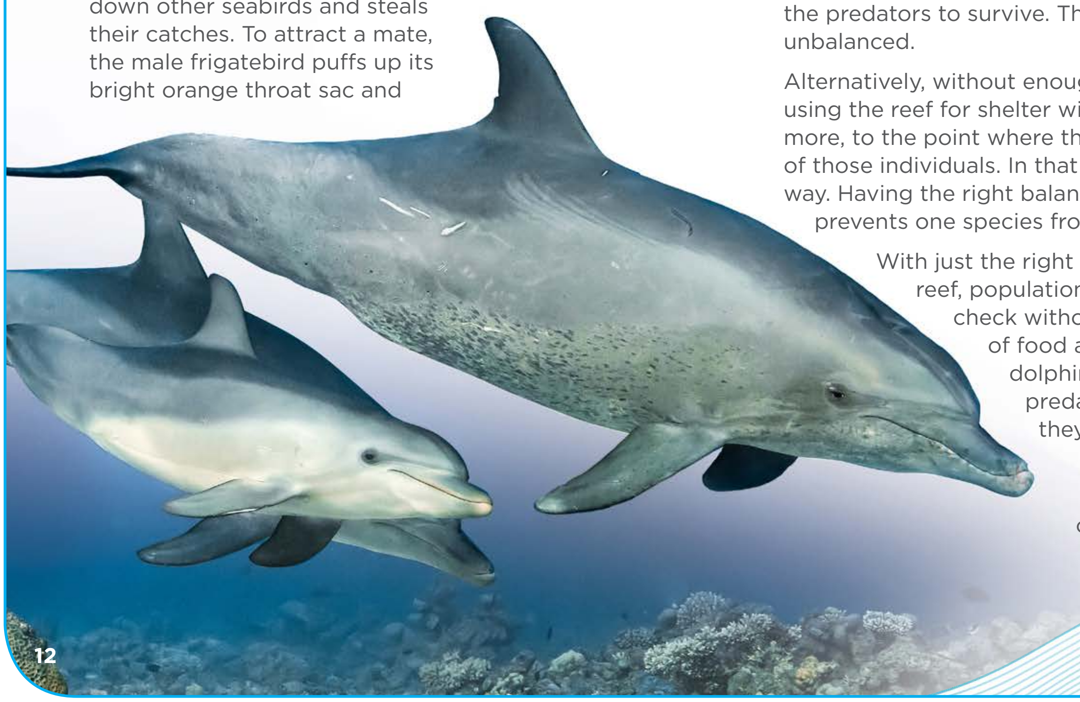
Dolphins in a Balanced Ecosystem

Like all ecosystems, coral reefs must maintain a balance between predators and prey. It is easy to imagine what might happen if a reef becomes damaged and cannot protect as many animals: attacks by predators will outpace the ability of prey species to reproduce and their population numbers will decline. Soon there is not enough food for the predators to survive. The reef ecosystem then becomes unbalanced.

Alternatively, without enough predators around, the animals using the reef for shelter will survive longer and reproduce more, to the point where the reef is unable to support all of those individuals. In that case, the balance tips the other way. Having the right balance between predators and prey prevents one species from taking over.

With just the right number of dolphins near a reef, populations of prey species are kept in check without outstripping the amount of food available for the population of dolphins. The same is true for other top predators and the food webs to which they belong.

For instance, a healthy coral reef is where many different species of sharks will find their favorite



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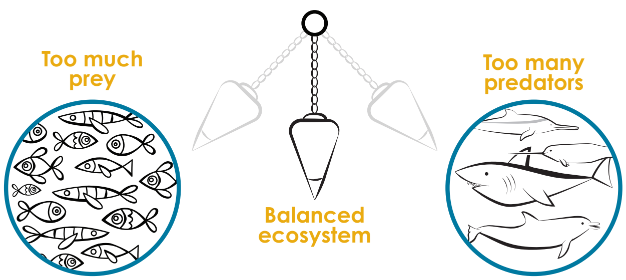
foods. Scientists have found that the healthiest coral reefs have the most sharks. The presence of this top predator in abundance, even outnumbering the prey species, keeps the entire ecosystem in balance. This relationship between predator and prey is constantly swinging back and forth like a pendulum over a point of perfect balance. If the pendulum is pushed too far in one direction or the other, then the ecosystem is unbalanced and one group or the other will suffer until balance is restored.



In addition to the carefully balanced relationships between predators and prey, there are animals sharing the coral reef ecosystem that have developed cooperative relationships. These partnerships, known as mutualisms, involve two different species sharing a space to the benefit of both. One common example is the symbiotic mutualism between clownfish and sea anemones. Sea anemones use toxic tentacles to sting and catch fish as their food. Clownfish can develop a chemical camouflage to the venom in order to hide in the sea anemones' tentacles. The clownfish receives protection from predators and, in return, the sea anemone benefits by keeping water flow over their tentacles to bring in oxygen and microorganisms to eat.

Dead Zone

In some regions of the ocean, there are no fish, corals, seabirds, invertebrates or even marine mammals. These "dead zones" are areas with very low levels of oxygen, a condition called hypoxia. Without sufficient oxygen, plants and animals die or leave, and the only life that can be sustained are bacteria. Some dead zones occur naturally in the ocean and in lakes. Other dead zones are created by human activity, such as fertilizer run-off, which disrupts the balance of coastal ecosystems.

Threats to a Dolphin's Reef Retreat

Forces that cause an ecosystem to become unbalanced include both natural and anthropogenic (or human-made) causes. For coral reefs, one of the greatest threats is an anthropogenic one: rising water temperatures. When fossil fuels are burned for energy, more and more carbon dioxide is added into the atmosphere. This buildup acts like a blanket that traps heat around the world, which disrupts the climate. One result is warmer ocean temperatures. As the ocean temperature rises beyond a certain point, coral polyps expel the algae living in them, losing both their food source and their coloration. This condition is known as coral bleaching.

At the same time, the ocean absorbs some of the extra carbon dioxide emitted into the atmosphere when fossil fuels are burned, and that changes the chemistry of the ocean, which is called ocean acidification. Ocean acidification causes "osteoporosis of the sea," which prevents animals like corals from building and maintaining the calcium carbonate skeletons they need to create reefs. Just as humans need calcium to build their bones, corals and other sea animals need calcium carbonate to build strong skeletons and shells. The addition of rampant carbon dioxide is reducing the amount of calcium carbonate in the ocean and degrading coral reefs.

Regular carbon dioxide is used and created by normal life processes, but excessive carbon dioxide comes from burning fossil fuels for energy. When we burn fossil fuels we put a lot of stress on the ocean, damaging its ability to keep the climate stable. As a result of this stress, sometimes the ocean pumps too much heat and moisture throughout the system; sometimes too little. If we think about the ocean as the heart and bloodstream of the climate, it is clear that we need to prevent further damage to it. A heart must be monitored and cared for to ensure overall health and functioning, and the best care is preventative care.

The ocean is vital to life on Earth. Scientists estimate that ocean plants produce as much as 90% of the planet's oxygen. One third of the carbon dioxide that is produced globally is absorbed by the ocean, helping to prevent overheating of the planet. We can help the ocean perform these functions more effectively by reducing the amount of carbon dioxide produced through human activity.

The balance of a coral reef ecosystem can also be disrupted by overfishing. Over-harvesting of fish results in an imbalance between predator and prey and can cause coral reefs and all their inhabitants to suffer. If the population of a particular species dips below a critical point, it may not be able to recover and could be fished to extinction. In areas where sharks are harvested for their fins, those species are in rapid decline.

Another anthropogenic threat to dolphins and other sea life is marine pollution. Plastics in particular are problematic because of their durability and ubiquity. Non-biodegradable plastic that finds its way to the ocean gets broken into smaller and smaller bits and can be mistaken for plankton by filter feeders like humpback whales. Plastic bags resembling jellyfish can choke sea turtles that try to eat them. Plastic with rough edges can damage the sensitive skin of dolphins or worse, tangle them up in plastic rope or fishing line.

People Caring for the Ocean

Being responsible with our natural resources is important for the health of our oceans. Looking to evidence, keeping an open mind and focusing on the best ways to solve a problem are part of being responsible. Future generations depend on the decisions and plans we make today. Practical, feasible, step-by-step approaches allow us to make real progress on longstanding challenges and obstacles.

For example, you can:

- **Choose sustainable seafood** to keep fish and shrimp populations in balance.
- **Advocate for Marine Protected Areas** (MPA's) to help ensure healthy reef ecosystems and restore fish populations to robust levels.
- **Reduce single-use disposable plastics** every day by using sturdy, reusable water bottles, reusable shopping bags and lightweight utensil kits. Support community efforts to ban plastic bags and plastic water bottles and recycle these materials to keep harmful plastics out of the ocean.
- **Avoid items with plastic micro-beads** when purchasing personal care products such as soaps and shampoos. Due to micro-plastics being smaller than 1 mm, they are often not filtered out during waste water treatment and end up polluting water systems.
- **Visit marine sanctuaries** to connect with nature and learn more about these special areas managed by NOAA, the National Oceanic and Atmospheric Administration.
- **Spend time at the seashore**, appreciating what the ocean provides to find inspiration for teaching others about this important ecosystem.
- **Make wise choices when celebrating** or honoring loved ones. When helium-filled balloons are released into the air accidentally or intentionally they commonly fall into the world's oceans, and may harm ocean animals. Make sure balloons are secured tightly or have weights attached to their strings to ensure they stay in place. You can even choose alternative forms of celebration like ribbon dancer wands, bubble wands or flying kites!
- **Visit your local AZA-accredited aquarium** to learn more about oceans and the species that live there.
- **Go to DisneyAnimals.com** to learn more about incredible ocean animals.

The more we know about a species or ecosystem, the more likely we are to understand why it is important to save them and to actively generate ideas to protect the ecosystems where they live. Taking practical, common sense steps to address problems facing our environment today is in the best interest of future generations. We must protect and preserve the habitats and ecosystems dolphins and their ocean neighbors depend on.

The Disney Conservation Fund

The Disney Conservation Fund helps to protect many of the ocean's most threatened species including sea turtles, sharks, rays and coral reefs. Since 1995, the Disney Conservation Fund has directed more than $80 million to save wildlife and protect the planet and inspired millions of people to take action for nature in their communities.

You can learn more about the Disney Conservation Fund by visiting Disney.com/conservation

Animal Glossary

Bottlenose Dolphins

SIZE:
6–12.5 ft (2–4 m)

DIET:
Fish, squid & other invertebrates

PREDATORS:
Large sharks

Known for their problem solving, charismatic personalities and sleek hydrodynamic build, bottlenose dolphins can often be spotted jumping out of the water or surfing the waves along the coast. Bottlenose dolphins are marine mammals and live in oceans worldwide with the exception of the polar regions. They are social animals and live in "fission-fusion" communities that flexibly reorganize themselves throughout the day. Some individuals will remain together for longer periods—such as mothers and their calves that stay together for 3–5 years, and males will pair up for decades. These small units will temporarily form units with others for socializing and hunting. Dolphins produce a wide variety of three types of vocalizations to communicate with each other (whistles, clicks and burst pulses), and also use echolocation to hunt. Echolocation uses sound waves to bounce off nearby objects, creating an echo that transmits back through the dolphin's lower jaw to its ear and is detected by the brain. Dolphins use a variety of hunting techniques such as creating mud rings to entrap fish or using sea sponges to protect their rostrums as they root around rocky areas for prey!

FUN FACT **Dolphins keep half their brain awake while sleeping which helps them continue to swim, breathe and look out for predators.**

Cuttlefish

SIZE:
11–19 in (30–49 cm)

DIET:
Crustaceans & fish

PREDATORS:
Large fish, seals, sharks & dolphins

Cuttlefish are mollusks, related to octopuses and squid. They are known to display some of the most brilliant camouflage in the animal kingdom. They are well-known not only for their vibrant colors, but also their ability to seemingly change the shape of their bodies to remain concealed to prey and from predators. Camouflage allows the cuttlefish to sneak up on its prey so it can launch its long tentacles to grip the next meal. They also have strong beaks that can pierce hard crustacean shells. These invertebrates are related to octopus and have ink they can expel to distract predators as they make their getaway from threatening situations. Cuttlefish typically move to shallow water during breeding season and lay eggs which incubate for 30–90 days before hatching. Scientists think the temperature of the eggs may determine how fast or slow they develop, but all newly hatched cuttlefish measure just under two inches (5 cm). These colorful animals are most active at night and typically like to stay near the ocean floor.

FUN FACT **Cuttlefish use their bright, changing colors to communicate with each other via visual cues.**

Corals

SIZE: Varies by species | **DIET:** Zooplankton, nutrients produced by their symbiotic algae | **PREDATORS:** Sea stars, fish & snails

Corals come in many different shapes, sizes and colors. Although they resemble plants or rocks, corals are actually animals that live in warm, shallow ocean water and are related to jellyfish! Corals are made of polyps, which are different from the bodies of most other animals. Some corals are just one single polyp and others are made of multiple identical polyps that form a colony. Polyps have soft, tube-like bodies that measure anywhere from smaller than 0.5 inch to 11 inches (1–30 cm) long with a mouth in the middle that is surrounded by stinging tentacles. To protect themselves, some corals build a hard skeleton around the polyps using minerals found in the water. Corals grow very slowly and can be affected by uncontrollable conditions, such as the temperature and pH of the ocean water. When many corals grow together, they create habitat known as a coral reef.

FUN FACT Some corals have stinging tentacles near their mouths which helps them immobilize their food and defend themselves from predators.

Stingrays

SIZE: 11–19 in (30–49 cm) | **DIET:** Crustaceans & fish | **PREDATORS:** Large fish, seals, sharks & dolphins

There are over 60 different species of stingrays, and as their name suggests, they have venomous spines, or barbs, which they may use to protect themselves. Stingray mouths are on the underside of their flat, disc-shaped bodies whereas their eyes are situated on the tops of their heads. Most stingrays prefer to burrow in sand or mud in shallow waters, but some are known to migrate and swim freely in open water. Stingrays can be found in all tropical and subtropical waters, and they are similar to humans in how they use their senses such as sight, hearing, smell, taste and touch to understand the world around them.

FUN FACT Stingrays share many features with sharks, such as having skeletons made of cartilage, sensitivity to electrical patterns around them and giving birth to live young rather than in an external egg.

Humpback Whales

SIZE: 45–56 ft (13–17 m) | **DIET:** Krill & fish | **PREDATORS:** Orcas & sharks

Named after the distinctive hump under their small dorsal fin, these massive whales are known for their beautiful vocalizations and large displays in the ocean as they breach and splash. Humpback whale vocalizations, sometimes referred to as songs, are thought to be part of courtship behavior. These whales are filter feeders, meaning they take in large amounts of water and expel the water filtering out the krill and fish they eat. Sometimes humpback whales will work together to catch food by creating a bubble net. To create a bubble net, a group of whales swim in circles while producing a continuous stream of air which traps the tiny prey in a net of bubbles, ready to eat! They are known to travel thousands of kilometers during migration season and typically return to the same feeding grounds annually. Scientists can use the pattern of black and white markings on the whale's tale to identify individuals—just like a fingerprint!

FUN FACT Humpback whales hold the record for the longest pectoral flippers proportionally of any whale. Their flippers can measure up to 16 feet (5 m) long—a third of their body!

Orcas

SIZE:
23–32 ft (7–10 m)

DIET:
Fish, sharks and rays, marine mammals, sea turtles, fish, penguins & seabirds

PREDATORS:
No natural predators

Orcas, also known as killer whales, are social and curious marine mammals found as far north as the Arctic Ocean and as far south as the Antarctic Ocean. The migration patterns of orcas are not well understood, but they do travel with members of their matriline—that is, their mothers, grandmothers and cousins. Closely-related matritrilines will often come together for short periods of time into larger groups, called "pods". Several pods that share a unique set of calls exist within an even larger group called a clan. Orcas, as with all toothed whales and dolphins, have an auditory bulla, or an ear bone complex similar to the structure inside human ears. However, unlike humans, orcas receive sounds from the water through a very thin bone in the lower jaw. The sound is then transmitted through "acoustical fat" in the jaw to the orca's auditory bulla. This adaptation allows the orca to hear underwater sounds efficiently, which they use to communicate as well as to navigate their surroundings. Orcas are apex predators which means that they are at the top of the food chain and do not have any natural predators except for humans.

FUN FACT It is widely assumed that orcas only live in cold water but they have also been observed in warm water areas such as Hawaii, Australia and The Bahamas.

Tiger Sharks

SIZE:
10-14 ft (3–4.2 m)

DIET:
Crustaceans & fish

PREDATORS:
Large fish, seals, sharks & dolphins

These top ocean predators get their name from their tiger-like stripes that fade as they age. Baby tiger sharks, called pups, are born fully developed and independent. As adults, this species of shark is relatively large; however, they grow slowly, not reaching maturity until around 12-18 years of age. The largest tiger shark on record grew to be approximately 18 feet (5.5 m) long! These carnivores have sharp, serrated teeth with powerful jaws which they use to chew through hard shells of some of their prey such as sea turtles. Tiger sharks are known for being particularly curious and tend to prefer coastal habitats. They have even been known to venture into brackish water, which is where freshwater flowing from land and ocean saltwater mix.

FUN FACT Litters of tiger shark babies, called pups, can include anywhere from 10 to 80 individuals!

Parrotfish

SIZE:
1–4 ft (0.3–1.2 m)

DIET:
Algae & coral polyps

PREDATORS:
Fish

The beaklike teeth of the parrotfish are likely the inspiration for its unique name. The parrotfish's fused teeth are very strong and look similar to that of the beak of a parrot. These teeth allow them to grind and pulverize chunks of coral in order to eat the algae-filled polyps inside. Although parrotfish live in a variety of coral reef habitats, they are most commonly found in shallow reefs. Parrotfish have a variety of adaptations that aid in their survival such as eyes that can move independently, allowing them to see all around their bodies, except for behind them. Young parrotfish hatch only 25 hours after their eggs have been laid. Typically, the majority of hatchlings are female, and coloration varies between males and females. Coloration can also vary as the fish age, for example, juvenile fish may be reddish brown with white spots, and may change to be green with orange bands and yellow spots as an adult.

FUN FACT Young parrotfish hatch without eyes or a mouth! These develop later as the fish grows.

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Grey Reef Sharks

SIZE: 2-4 ft (0.60-1.2 m) | **DIET:** Octopuses, squid, crustaceans & fish | **PREDATORS:** Large sharks & orcas

These sharks can be found near the water's surface close to islands and coral reefs of the Pacific and Indian oceans. Grey reef sharks are recognizable by their white undersides and black bands along the edge of their tails and tips of their pectoral fins. These sharks have very acute senses, including excellent sight in low lighting, an impressive sense of smell and remarkable hearing by detecting sound vibrations in the water. Grey reef sharks can be territorial, and some scientists believe they will communicate a warning to trespassers by arching their back and pointing the pectoral fins downward while swinging their head from side to side. During the day, grey reef sharks swim in groups called schools, but they become solitary at night when they are most active. Scientists believe grey reef sharks can live to be about 25 years old, but they're still learning about these top predators. Grey reef sharks are currently classified as near threatened, but conservation organizations are working hard to prevent the decline of their populations.

FUN FACT **Grey reef sharks are ovoviviparous, which means that their pups hatch from eggs within the body of the mother and then emerge as a live birth.**

Peacock Mantis Shrimp

SIZE: 2-7 in (5-18 cm) | **DIET:** Invertebrates like crabs, mollusks & gastropods | **PREDATORS:** Large fish

These incredible crustaceans are known for their brightly colored body and impressive club-like appendages. Named after the peacock because of their coloration, and after the praying mantis because of their posture, peacock mantis shrimp are nocturnal, which means they are more active at night. To facilitate their nighttime activity, this invertebrate can see in infrared and ultraviolet light as well as move their two eyes independently of each other. Their sight, however, might be the mantis shrimp's second most impressive adaptation, following the club they use for hunting and to defend themselves and their territory. This appendage acts as a spring-loaded gun, and can hit with such force that they are capable of breaking through quarter-inch thick glass. Peacock mantis shrimp can be found burrowing into substrate and prefer to live in crevices of coral or rock in the warm waters of the Indian and Pacific oceans.

FUN FACT **Peacock mantis shrimp will continuously abandon their burrows only to make new ones, leaving their old homes to shelter other species.**

Hawksbill Sea Turtles

SIZE: 4 ft (1.2 m) | **DIET:** Sea sponges, sea jellies & anemones | **PREDATORS:** Adults are preyed upon by sharks and crocodiles. Hatchlings are preyed upon by a variety of fishes and seabirds. Eggs are eaten by beach crabs, raccoons, mongooses and a number of land mammals.

Hawksbill sea turtles are marine reptiles that have a protective heart-shaped shell, or carapace. The name hawksbill comes from the unique hawk-like beak, which the turtle uses to probe crevices in coral reefs for their favorite food—sponges. Hawksbill sea turtles are found in warm seas throughout the tropics where they reside in reef, hard-bottom and seagrass habitats. Female hawksbill sea turtles come ashore to lay eggs in nests in the sand between summer and early fall, or during the tropical rainy season. After laying her eggs and covering them with sand, the female turtle returns to the sea. Like other species of sea turtle, the incubation temperature of the eggs determines whether the hatchling turtles are male or female. Hawksbill sea turtles are listed as critically endangered, meaning their population is declining and in need of conservation efforts.

FUN FACT **Hawksbill sea turtles eat sponges with glass-like skeletons and toxins that would be highly poisonous to other animals.**

Resources

Books:
Franklin, C. (2008) *Ocean Life (World of Wonder)*. Children's Press, CT.

Nelson, R. L. (1997) *Our Ocean Home*. Cooper Square Publishing, LLC.

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Stahl, D. (2009) *Dolphins*. The Child's World, Inc.

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Woodward, J. (2012) *Look Closer Ocean*. DK Children.

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http://www.aquariumofpacific.org

Census of Marine Life:
http://www.coml.org

Conserve Turtles:
http://conserveturtles.org/information-about-sea-turtles-hawksbill-sea-turtle/

Cornell Lab of Ornithology:
http://www.allaboutbirds.org

IUCN Red List:
http://www.iucnredlist.org

Marine Bio:
http://marinebio.org/oceans/dolphins/

Monterey Bay Aquarium:
http://www.montereybayaquarium.org

National Aquarium:
https://aqua.org/explore/animals/mantis-shrimp

National Network for Ocean and Climate Change Interpretation with support from Frameworks Institute:
http://frameworksinstitute.org

Smithsonian Ocean Portal:
http://ocean.si.edu
- **Sharks:** http://ocean.si.edu/sharks
- **Ocean Trash:** http://ocean.si.edu/ocean-news/ocean-trash-plaguing-our-sea
- **Have your Fish and Eat it Too:** http://ocean.si.edu/ocean-news/having-your-fish-and-eating-them-too

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Ocean Dead Zones:
https://www.scientificamerican.com/article/ocean-dead-zones/

http://oceanservice.noaa.gov/facts/deadzone.html

WWF Humpback Whale Species Profile:
http://wwf.panda.org/about_our_earth/species/profiles/mammals/whales_dolphins/humpback_whale/

Coral Bleaching:
https://vimeo.com/7444395

http://news.nationalgeographic.com/2016/08/coral-bleaching-video-algae-warming-oceans-environment-science/

https://www.youtube.com/embed/_ZfGIKiSwwQ (HHMI video)

http://www.bbc.com/news/world-australia-38127320

Ocean Acidification:
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https://oceantoday.noaa.gov/oceanasalab_oceanacid/

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Lesson 1

GRADES: 3-6

SUBJECT: Science

BACKGROUND INFORMATION: Pages 7-10

STUDENTS WILL BE ABLE TO...

- Compare and contrast the adaptations of bottlenose dolphins, humpback whales and grey reef sharks.
- Use the CER (claim, evidence, reasoning) framework to create a scientific argument answering the driving question for this lesson.

VOCABULARY: adaptation, cladogram, organism, species

WHAT YOU'LL NEED:

- *Activity Sheet 1: Cladogram*
- *Activity Sheet 2: Matrix for Dolphins, Sharks and Whales*
- *Activity Sheet 3: Memory Game,* cards cut out and laminated
- Pencils
- Dry erase pens

Dolphins, Sharks and Whales

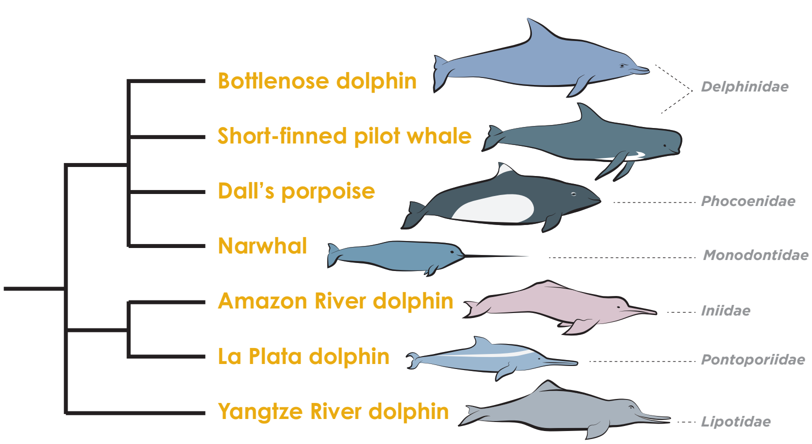
Adaptations and Relationships (Grades 3–6)

Warm Up

Ask how many students have created a family tree. Why are so many people interested in family trees and websites that connect people with information on their ancestors? (e.g., to find relatives, to understand their family history, to discover where their ancestors originated, etc.). Scientists are interested in family trees of a different kind. Explain that in this lesson students will get to see how scientists figure out the relationships among a range of **species**.

STEP 1: Distribute *Activity Sheet 1: Cladogram*. Explain to students the illustration is called a **cladogram**. This cladogram shows several species of dolphin, including the bottlenose dolphin, the featured species from Disneynature **DOLPHIN REEF**.

First, ask each student to think about what the picture is intended to show or demonstrate. Second, ask students to turn to a peer to discuss their thoughts. Third, invite a few pairs to share their ideas with the whole class. Explain that biologists use a cladogram to show the relationship between different species.



This cladogram uses a branching diagram to show the relationship between several dolphins. Note that the fewer branches there are between two species, the closer those two species are related in that they share a common ancestor. For example, the bottlenose dolphin in the cladogram is more closely related to a Dall's porpoise than to an Amazon River dolphin. Point out that there are fewer branches between bottlenose dolphin and Dall's porpoise (one branch) than between the bottlenose dolphin and the Amazon River dolphin (three branches).

Note to the teacher: The branches represent relationships, they do not "cause" relationships. In interpreting the cladogram, it is acceptable to say that the cladogram shows the bottlenose dolphin is more closely related to a narwhal than to an Amazon river dolphin. It is not, however, accurate to say that this is because they are separated by fewer branches.

STEP 2: Ask students to think like a biologist by considering how they construct a cladogram. How do they figure out how closely related two species are? How did they determine if the bottlenose dolphin is more closely related to Dall's porpoise than the Amazon River dolphin? Explain that the more closely related two species are, the

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Lesson 1

Dolphins, Sharks and Whales

more **adaptations** they have in common. Some adaptations are easily visible (e.g. all dolphins have flippers). Some adaptations can only be seen by looking inside the animal's body (e.g. X-rays or MRIs). Ask students for some examples of adaptations that scientists might use to determine how closely related **organisms** are. Write these on the board for use later. Some of the most important adaptations include how an animal breathes, how it gives birth, how it regulates body temperature (warm blooded vs. cold blooded) and how its nervous system developed (does it have a brain; does it have a spinal cord).

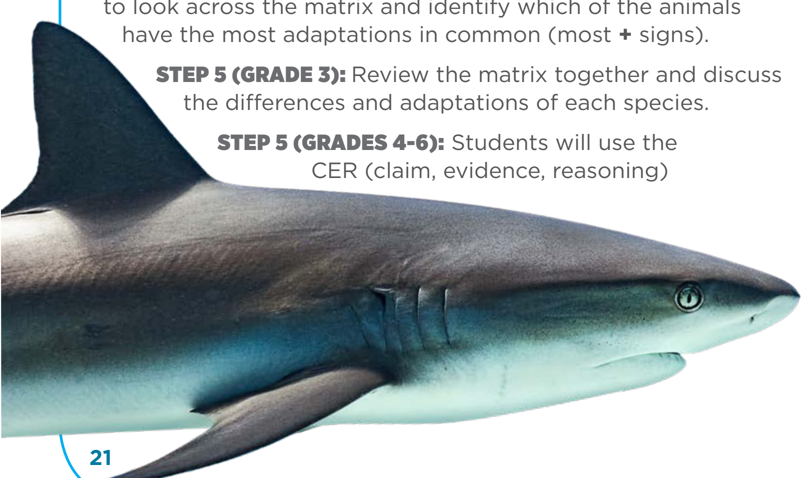
STEP 3: Even though Disneynature **DOLPHIN REEF** focuses mostly on bottlenose dolphins, the film also includes other marine species, such as humpback whales and grey reef sharks, that also share similarities based on adaptations. Distribute *Activity Sheet 2: Matrix for Dolphins, Sharks and Whales*. Ask students to try and determine where on a cladogram the three animals would fall. The driving question for this lesson is: Which species is more closely related to bottlenose dolphins—humpback whales or grey reef sharks?

Ask students to use the pictures and their background knowledge to fill out as much of the matrix as they can. They will place a "**+**" sign in the matrix when an adaptation aligns with a specific marine animal. If the adaptation does not align, students will put a "**–**" in the grid. If the adaptation aligns, ask them to provide an answer or brief example on a separate page. For example, in the row for how the animal breaths, dolphins use their lungs. A possible answer/student example might state, "*Dolphins breathe using lungs and their blowhole. Dolphins must frequently return to the surface of the water in order to breathe.*" They will also need to provide an example of lungs for humpback whales and gills for grey reef sharks.

STEP 4: Students may not be able to fill out all of the matrix based solely on the pictures. Have students use books and the internet to fill out additional information. They should be on the lookout for adaptations they can include that further help them clarify the similarities and differences among the three animals. After concluding their research, ask students to look across the matrix and identify which of the animals have the most adaptations in common (most **+** signs).

STEP 5 (GRADE 3): Review the matrix together and discuss the differences and adaptations of each species.

STEP 5 (GRADES 4-6): Students will use the CER (claim, evidence, reasoning) framework to write and construct a scientific argument and provide evidence that supports their answers about which of the two marine animals are more closely related to the bottlenose dolphin. The CER framework involves three steps that require students to a) make a *Claim*, or an answer to a question; b) provide *Evidence* that supports the *Claim*; and c) give their *Reasoning* for how the *Evidence* supports their *Claim*. Students can either create their arguments individually or in groups of 2-4.



To simulate how scientists actually share results, hold a "poster session" and gallery walk. For the poster session, students should present their arguments on chart paper posted on the walls around the room. Students view the posters, consider the arguments and compare their own work with the work of other students. To mirror how poster sessions are held at scientific conferences, ask some of the students to stay at their posters to talk to other students about how they constructed their arguments. Provide the opportunity for students to exchange roles. For example, the scientifically accurate claim is that humpback whales are more closely related to bottlenose dolphins than grey reef sharks. The evidence supporting this claim should be the adaptations that each species has in common. The reasoning is that there are more adaptations in common between humpback whales and bottlenose dolphins than adaptations in common between grey reef sharks and bottlenose dolphins.

Note: If students have not used the CER framework before, use sentence starters to help them write and prepare their arguments.

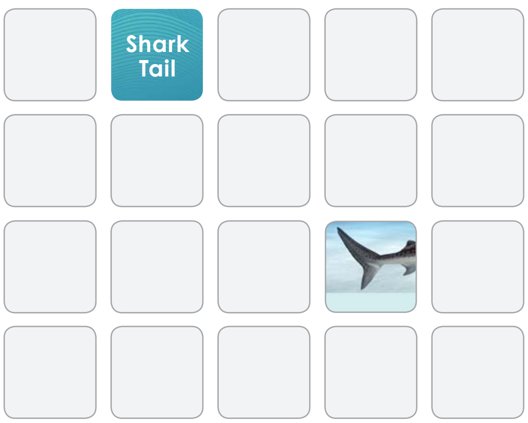
1. *Claim*: Bottlenose dolphins are more closely related to...
2. *Evidence*: Bottlenose dolphins and humpback whales share the following adaptations....
   (or)
   Bottlenose dolphins and blacktip reef sharks share the following adaptations...
3. *Reasoning*: The evidence supports this claim because...

STEP 6: Provide students with laminated sets of memory game cards cut from *Activity Sheet 3: Memory Game*. Students will use the cards to play a memory game that helps them identify and remember types of marine animal adaptations. They will also be able to use the cards to figure out which marine animals have the most adaptations in common.

Lesson 1

Dolphins, Sharks and Whales

PLAY THE GAME
Peer pairs sit across from each other with the set of memory cards placed face down in a grid pattern between them. Students alternate turning over two cards at a time. When the word of the adaptation matches the picture of the adaptation, students take the matched pairs. After all of the cards are matched, the student who has matched the most pairs wins.



Wrap Up (Grade 3)

Reflect on the adaptations. Give students a dry erase pen and ask them to write under the picture of the adaptation the species of the animal seen in Disneynature **DOLPHIN REEF**. Remind students to pay extra attention to identifying dolphins, whales, and sharks that have those adaptations. Students may sort the annotated cards into groups to determine which groups of animals have the most adaptations in common. Discuss the different ways students sorted the cards.

Wrap Up (Grades 4-6)

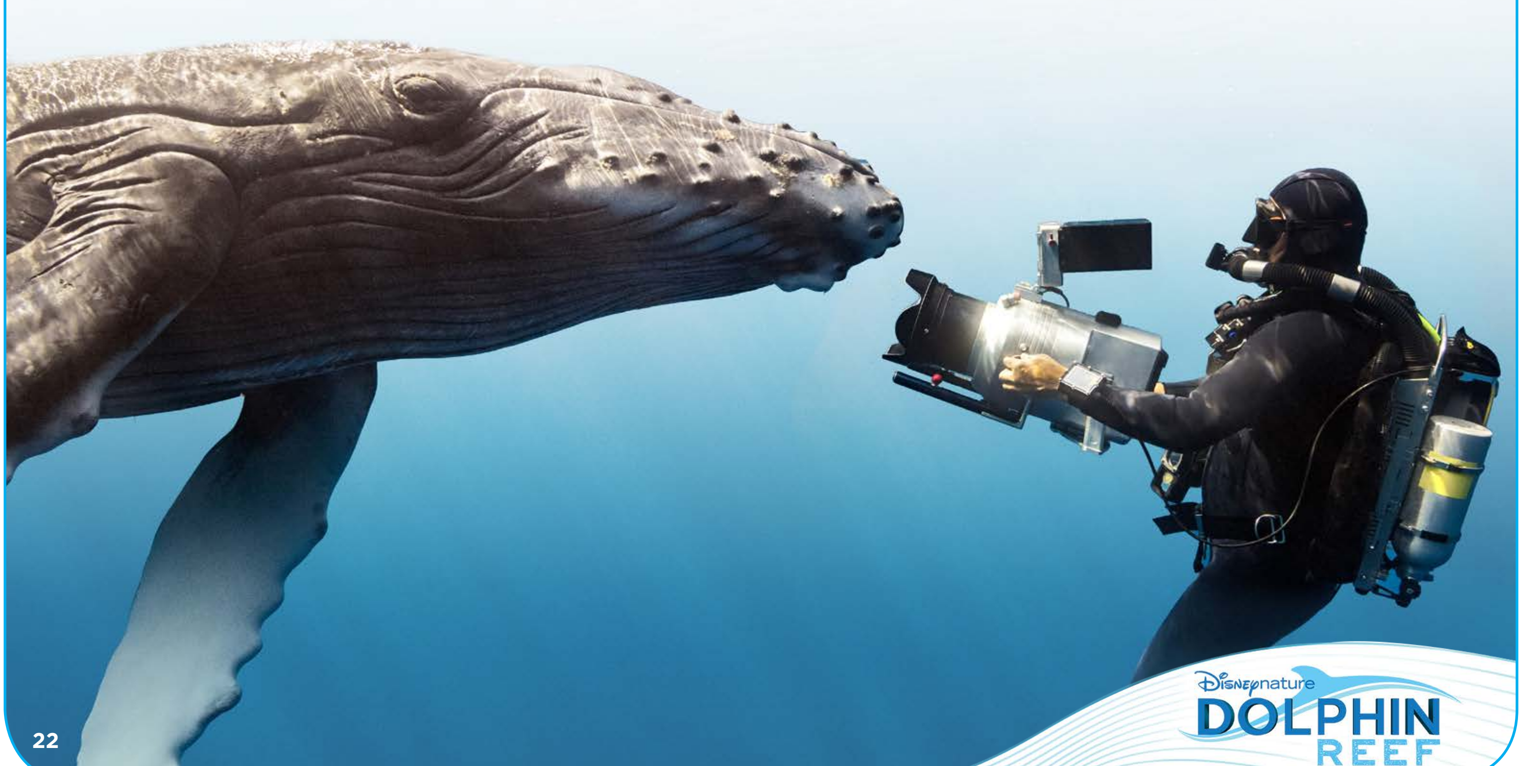
Ask students to think about why we want to know how closely organisms are related. Why do scientists want to know if a humpback whale is more closely related to the bottlenose dolphin than a grey reef shark? (e.g. it can help us aid in conservation efforts for the reef; it can help care for animals in the wild and in human care.)

RESOURCES

https://www.teachervision.com/group-work/cooperative-learning/48547.html

https://en.oxforddictionaries.com/definition/cladogram

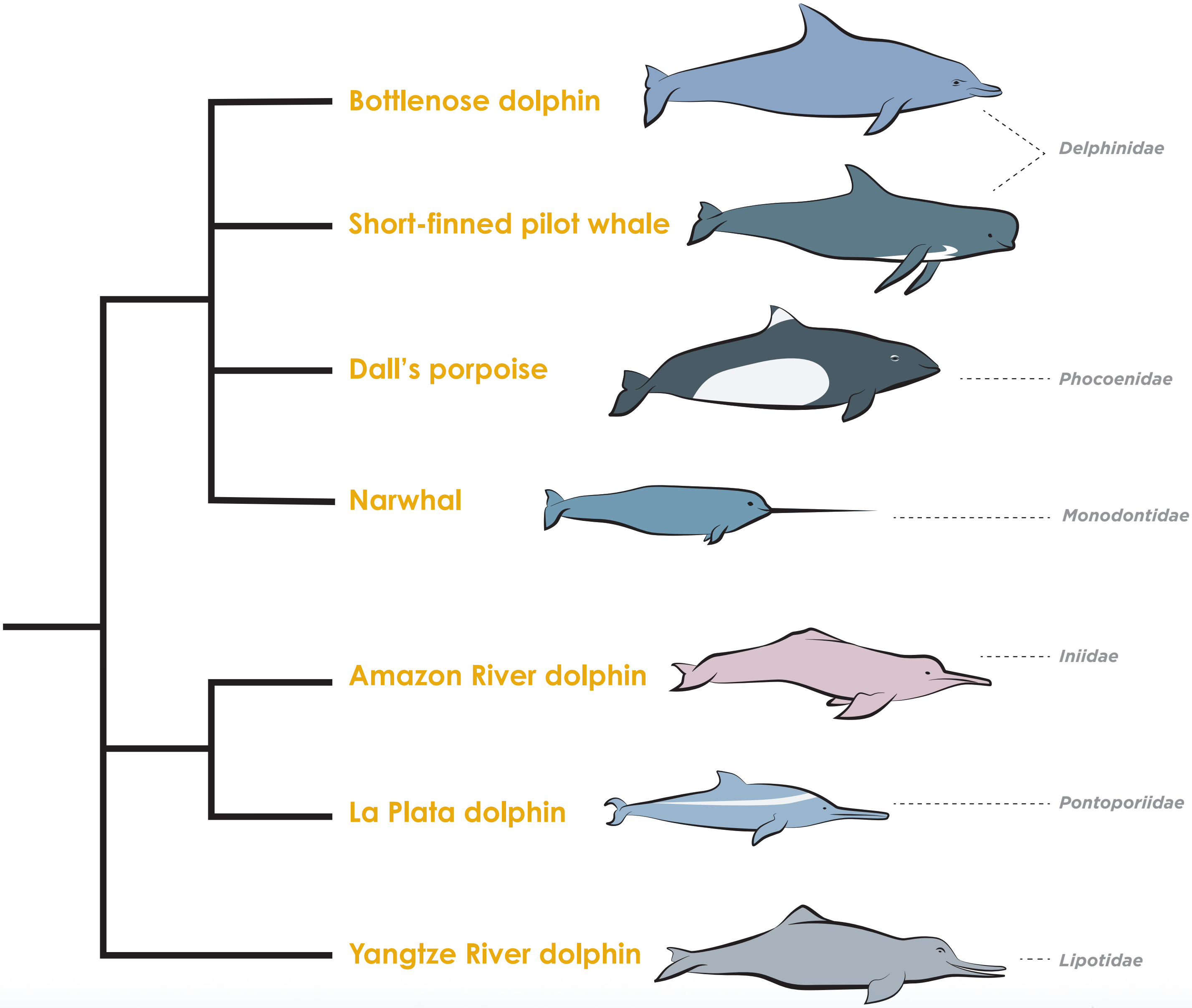
McNeill, K. L. & Krajcik, J. (2012). Supporting grade 5-8 students in constructing explanations in science: The claim, evidence and reasoning framework for talk and writing. New York, NY: Pearson Allyn & Bacon.

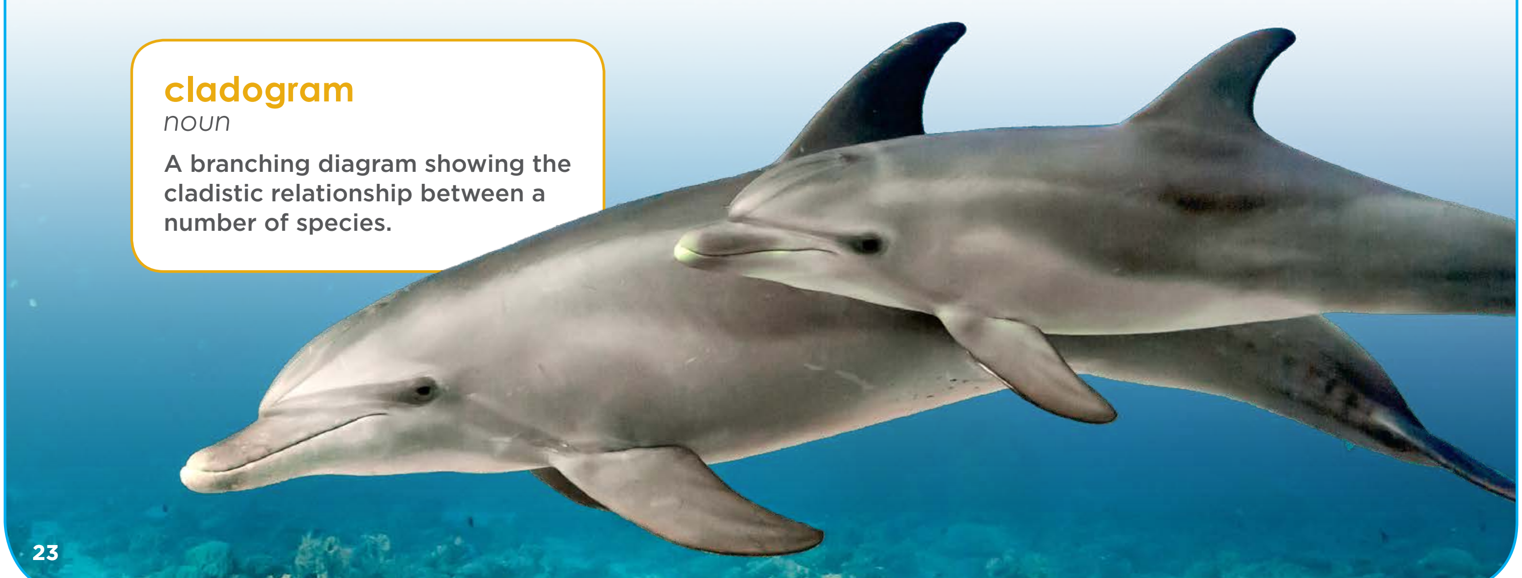


Disneynature DOLPHIN REEF

ACTIVITY SHEET 1

Cladogram





cladogram

noun

A branching diagram showing the cladistic relationship between a number of species.

1

ACTIVITY SHEET 2

Matrix for Dolphins, Sharks and Whales

Disneynature DOLPHIN REEF

Name ______________________ Date ______________________

DIRECTIONS: Place a "+" sign in the matrix when an adaptation aligns with a marine animal. If the adaptation does not align put a "–" in the grid. If the adaptation aligns, provide a brief example on a separate page.

Bottlenose Dolphin

Humpback Whale

Grey Reef Shark

Adaptations		Bottlenose Dolphin	Humpback Whale	Grey Reef Shark
1 How it Breathes	Lungs			
	Gills			
2 How it Produces Offspring	Live Birth			
	Lays Eggs			
3 Shape of Tail Fin	Horizontal			
	Vertical			
4 Blowhole	Present			
	Not Present			
5 Movement	Swims			
	Walks			
6 Dorsal Fin	Present			
	Not Present			
7 Rib Cage	Present			
	Not Present			
8 Skeleton	Bone			
	Cartilage			
9 Group Behavior	Lives in Groups			
	Solitary			
10 Body Temperature Regulation	Warm Blooded			
	Cold Blooded			

ACTIVITY SHEET 3

Memory Game

Teeth

Dolphin Tail

Grey Reef Shark

Bottlenose Dolphin

Whale Tail

Humpback Whale

Blowhole

A Pod

Shark Tail

Fin

Lesson 2

Dolphins as Predators

Foraging and Feeding (Grades 2–6)

SUBJECT AREA:
Focus: Art & Science
Extension: ELA

GRADES: 2-6

BACKGROUND INFORMATION:
Page 8

VOCABULARY:
animation, flip book, foraging, predator, prey, opportunistic

STUDENTS WILL BE ABLE TO...
- Compare and contrast the foraging and feeding behaviors and draw three sketches of how the process works from beginning to middle and end.
- Create a flip book animation of a bottlenose dolphin's foraging and feeding behaviors.

WHAT YOU'LL NEED:
- *Activity Sheets 1 a, b* and *c: Bottlenose Dolphins Foraging & Feeding Behaviors*
- Sticky note pads
- Drawing paper
- Pencils
- Markers
- Colored pencils or crayons
- World map

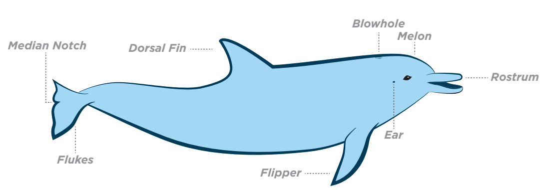
Warm Up

Ask students to close their eyes and imagine they are dolphins. As a dolphin, their behavior might be described as exuberant, playful and even social. It would not be unusual for them to be seen jumping, floating or surfing the wake alongside the bow of a boat. If they were young dolphins, they would even play tag or wrestle with one another. When it comes to getting eight hours of sleep daily, they would not snuggle down and close both eyes, but instead they would keep one eye open, allowing part of their brain to always stay awake. And just like humans, they would certainly have cravings to grab a meal or a snack, and the playful dolphin behaviors would then turn into those of a **predator**.

Before viewing Disneynature **DOLPHIN REEF**, trailer or clips, ask students to be on the lookout for the various ways bottlenose dolphins hunt for their food. Remind them that these predators have developed specialized **foraging** strategies that most often involve several dolphins hunting in a group. After viewing the film/clips, discuss the different hunting strategies that students noticed. Also, mention the type of foods that dolphins eat. Explain that they are opportunistic feeders, eating a variety of fish, squid and shrimp that are easily available.

Get Started

STEP 1: Before delving into foraging and feeding behaviors, invite students to learn more about bottlenose dolphin anatomy by drawing and completing a diagram. Have students draw a diagram of a bottlenose dolphin using the reference image on page 7 from the teacher's background information.



Ask guiding questions such as: how might this shape help a dolphin navigate through the ocean waters? How would a dolphin keep up with a fast-moving ship, or catch elusive prey? Point out dolphins' features, such as: rostrum, blowhole, dorsal fin, ear, eye, flipper, flukes, median notch, melon and toothed beak.

STEP 2: Inform students that scientists believe each dolphin foraging behavior is based on the depth of the water and geographic location, and while some tactics involve an individual dolphin, most involve cooperating groups. Write the following types of foraging and feeding behaviors on the board: mud circle, driver barrier, sponging, strand feeding, fish whacking and kerplunking. Invite students to speculate on what each of the behaviors mean. Arrange the class into three groups. Distribute one of the three activity sheets—*Activity Sheet 1 a, b* and *c: Bottlenose Dolphins Foraging & Feeding Behaviors* to each group of students. Students within groups may work in peer pairs. Ask each student to draw three sketches depicting how one of the two processes works from beginning to middle and end.

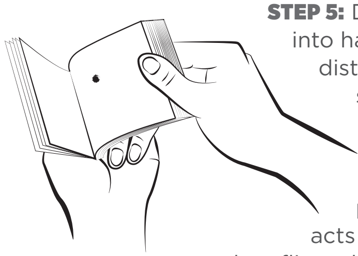
Disneynature DOLPHIN REEF

Lesson 2

Dolphins as Predators — Foraging and Feeding

STEP 3: Lead a discussion about the different types of foraging and feeding behaviors the students studied. Invite them to share their sketches of each of the behaviors. Discuss how the adapted behaviors relate to geographic location. For example, mud circles are made in shallow, muddy waters off the coasts of Florida, but dolphins that live in deeper water do not use those behaviors.

STEP 4: Share with students that stop motion **animation** is a technique that tricks the viewer's eye into seeing static objects move. Moreover, when students try their hand at creating stop motion animations, they have unique opportunities to analyze and gain insights into details of dolphin behaviors. Invite students to create an animated **flip book** that documents their favorite dolphin hunting tactic.



STEP 5: Divide the sticky note pads into half (1/2 per student), and then distribute them to the class. Tell students they will practice creating a simple animated flip book using a single dot on about 20 sticky note pad pages. Explain that each page acts as a still image frame, that when flipped gives the appearance of movement. To practice, students will draw a dot at the far-left corner of the first page of the note pad. On the second page, students will draw a dot but move it just a little further to the right. This process continues on each page of the pad until the dot is at the far-right corner of the pad. Once they have drawn the dot on each page and moved it slightly from the left to the right, tell them to flip the pages and watch the dot appear to move.

STEP 6: Once the students are comfortable with the process, have them choose a feeding and foraging tactic that they found interesting and animate the feeding pattern in a flip book. Refer them to the sketches they made on *Activity Sheet 1a, b,* or *c: Bottlenose Dolphins Foraging & Feeding Behaviors* where they visualized the beginning, middle, end of a bottlenose dolphin's foraging and feeding behavior. Help students understand that they will be drawing and keeping up with at least two dolphin predators and one prey as they plan out the animation. Students should color their animation.

STEP 7: Challenge students to share their animations in small groups and try to identify the different named behaviors: mud circle, driver barrier, sponging, strand feeding, fish whacking and kerplunking.

Wrap Up

Discuss the complex behaviors of dolphins, who are predators that follow unique patterns of hunting as they forage and feed. Address the role of cooperative hunting in being effective hunters. Invite students to discuss the pros and cons of each technique. Involve critical thinking questions, for example, would mud circles that occur in shallow waters be effective or even possible on a reef area in rock covered waters? If time permits, help students go even deeper in understanding the life of dolphins. Share videos of dolphin behavior and invite discussion about selected questions:

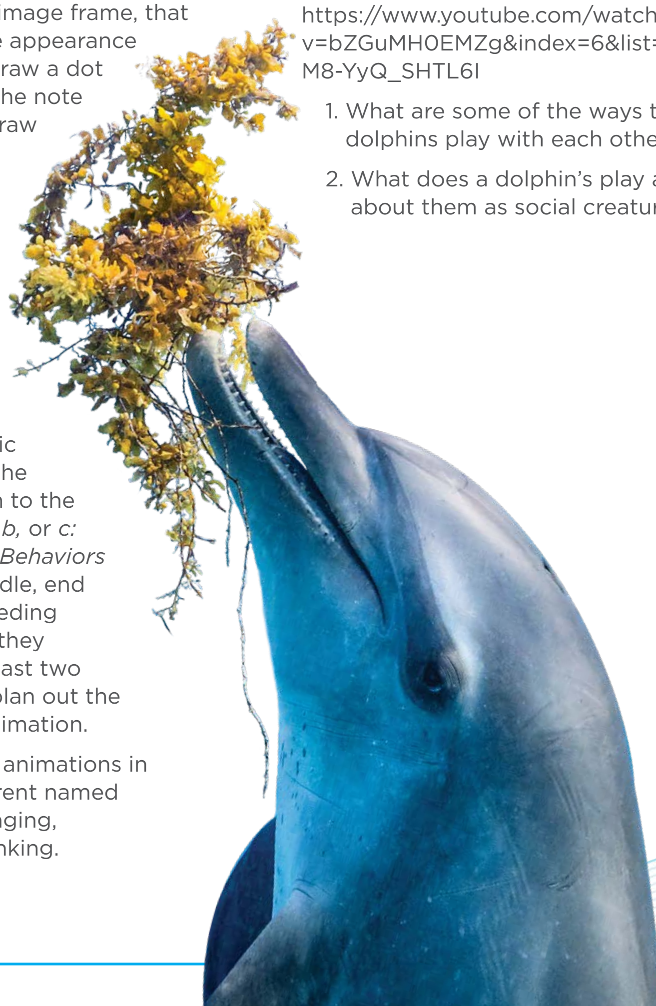
How do dolphins sleep without drowning?
http://www.smithsonianmag.com/videos/category/ask-smithsonian/ask-smithsonian-how-do-dolphins-sleep-witho/

How do dolphins sleep?
https://www.youtube.com/watch?v=I7yy4H1wiGI

1. What are the different ways that dolphins sleep?
2. How do dolphins sleep differently than fish, and why is it different?

How do dolphins play?
https://www.youtube.com/watch?v=bZGuMH0EMZg&index=6&list=PLQInTldJs0ZRlSQaZ99_M8-YyQ_SHTL6I

1. What are some of the ways that dolphins play with each other?
2. What does a dolphin's play activity tell us about them as social creatures?



Disneynature DOLPHIN REEF

Dolphins as Predators — Foraging and Feeding

Write a Dolphin DIY (Do It Yourself) Blog

Extension: ELA (Grades 2–6)

*Enrich students' insights into the unique characteristics of animals from Disneynature **DOLPHIN REEF** with extension activities from different content areas.*

STEP 1: Most people start writing a blog because they want to express their thoughts and opinions about a subject that's important to them. Many times, bloggers have a desire to help people who need advice. Some wish to simply have fun and be creative about sharing a hobby. The challenge for students in this activity is to assume the identity of a dolphin who wants to share how they learned specific techniques for foraging and feeding, perhaps through analysis and observations of other dolphins, or even by trial and error.

STEP 2: Share Student DIY Column Guidelines:

a) *Background*: Begin by sharing the story of how you became interested in a foraging and feeding strategy. For example, did you have trouble catching food one day? Did you need a snack but couldn't find one? Did you want your friends to form a foraging and feeding club?

b) *Tone*: Use a personal tone—as if you are sharing your experiences (even if they are a bit humorous), secret advice and insights.

c) *Language*: Keep it simple and fun.

d) *Purpose*: Decide if you will entertain, inform, educate or enable.

Next, ask students to brainstorm what young dolphins need to learn in order to be effective predators. Students should select one or two points to elaborate upon in a blog post.

STEP 3: Students should write two or three blog posts about something they learned when trying specific hunting techniques. Share students' blog posts on a class web page, or collect them in a class book.

WEB RESOURCES

https://www.hakaimagazine.com/article-short/tricky-hunting-tactics-dolphins

https://www.researchgate.net/publication/227520539_Where_to_catch_a_fish_The_influence_of_foraging_tactics_on_the_ecology_of_bottlenose_dolphins_Tursiops_truncatus_in_Florida_Bay_Florida

http://www.kiawahisland.com/blog/view/the-strand-feeding-practices-of-kiawahs-bottlenose-dolphins/

http://www.theatlantic.com/technology/archive/2014/04/these-genius-dolphins-are-using-sea-sponges-as-tools/361168/

http://sero.nmfs.noaa.gov/protected_resources/bottlenose_dolphins/fact_sheet/index.html

http://www.bbc.com/news/science-environment-32043822

https://www.reference.com/food/many-pounds-food-average-adult-eat-day-3f49d34cd3d872cd

BOOKS

Kay de Silva. Dolphins: Amazing Pictures & Fun Facts on Animals in Nature. Our Amazing World Series. Book 3. Amazon Digital Services LLC (2013) ISBN: 0987597027

Pamela S. Turner. The Dolphins of Shark Bay: Scientists in the Field. Books for Younger Readers. 2013, Houghton Mifflin. ISBN: 978-0-547-71638-1

ACTIVITY SHEET 1a

Bottlenose Dolphins Foraging & Feeding Behaviors

Disneynature DOLPHIN REEF

Name ______________________ Date ______________________

DIRECTIONS: Select one of the foraging and feeding behaviors below. Draw three sketches of how the process works from beginning to middle to end.

☐ **Mud Circle**

Dolphins create a mud circle as a way to capture fish. It is important to note that these mud circles are unique to the bottlenose dolphins off the coast of Florida. These dolphins swim into shallow waters and use their tails to tap the surface of the silty mud, creating plumes of mud cloud circles that disorient fish and act like a net.

or

☐ **Driver Barrier**

Dolphins use a driver barrier technique, in which one dolphin herds or drives the fish towards the other dolphins who line up next to each other so their bodies act as a barrier. The driver dolphin uses its tail to smack the surface of the water loudly while swimming around a group of fish in tight circles, leading them towards the other dolphins lying in wait. When the fish jump out of the water to escape, the barrier dolphins catch them in their mouths.

Beginning

Middle

End

ACTIVITY SHEET 1b

Bottlenose Dolphins Foraging & Feeding Behaviors

Disneynature DOLPHIN REEF

Name ______________________ Date ______________________

DIRECTIONS: Select one of the foraging and feeding behaviors below. Draw three sketches of how the process works from beginning to middle to end.

☐ **Sponging**

Dolphins carry sea sponges in their rostrums in order to protect their sensitive snouts from sharp rocks, stingrays and urchins while they search for prey.

or

☐ **Kerplunking**

A dramatic fin-slapping method in which dolphins leap in and out of the water while slapping the surface with their tail in order to concentrate and disorient fish nearby.

Beginning

Middle

End

ACTIVITY SHEET 1c

Bottlenose Dolphins Foraging & Feeding Behaviors

Name ______________________ Date ______________________

DIRECTIONS: Select one of the foraging and feeding behaviors below. Draw three sketches of how the process works from beginning to middle to end.

☐ **Fish Whacking**

A dolphin will hit a fish with its fluke to stun it. The stunned fish is then tossed into the air and splashes to the surface of the water. The dolphin can then leisurely capture and eat the fish.

or

☐ **Strand Feeding**

This practice involves a group of dolphins herding a school of fish or shrimp onto a sandbar or beach. The dolphins will then leap onto the shore in order to feed on their prey.

Beginning

Middle

End

Lesson 3

SUBJECT:
Focus: Social Studies
Extensions: Math & Art

GRADE:
Main Lesson: 2-4
Math Extension: 4-6
Art Extension: 4-6

BACKGROUND INFORMATION:
Pages 10, 11

STUDENTS WILL BE ABLE TO...
- identify healthy, unhealthy and transitional coral reefs through photograph analysis.
- locate coral reef areas on a world map.
- identify threats to coral reef health.
- analyze coral reef inhabitants via a simulation activity.
- create an artistic model of an artificial coral reef reclamation.

VOCABULARY:
algae, coral reef, Endangered Species Act, symbiotic relationship, transitional

WHAT YOU'LL NEED:
- *Activity Sheets:*
  - *1: World Map*
  - *2: Photo Analysis*
  - *3: Coral Reef Photos for Analysis*
  - *4: Dried Beans Record Sheet*
  - *5: Master Record Sheet For Classroom Simulation*
- Pencils
- Poster paper
- Markers

Math Extension:
- Bags of dried beans: white beans (large and small), colored beans (large and small)
- Masking tape to mark out squares on the classroom floor
- Two meter sticks

Art Extension:
- Six or more centimeter rulers (at least 30 cm in length)
- Clay
- Paper maché
- Glaze or paints
- Colored pencils
- Modeling clay
- Tools for manipulating clay-like materials (rollers, plastic forks, knives, spoons, texture tools, etc.)

Coral Reefs

Maintaining Healthy Ocean Life (Grades 2–4)

Warm Up

Ask students if they would be surprised to learn that coral reefs are sometimes called the "Rainforests of the Sea" and why. Inform the class that the name comes from the diversity of plants and animals living in this ecosystem as well as the similarities of the symbiotic relationship between the "layers" of the rainforest to the relationships of plant and animal life in coral reefs.

Remind students that all creatures need certain elements to be healthy and to thrive. Ask them to name the elements that species need to be healthy. Explain to students that, like people, coral reefs also have certain needs in order to thrive. Have students list what they believe need to be present for coral reefs to be healthy. Discuss the needs of a coral reef to be a healthy, active "community" of plant and animal life.

Divide the class into four discussion groups. Each group of students will focus on one of the following assignments:

a) discuss and list the conditions for a healthy human

b) discuss and list the conditions for a healthy dolphin

c) discuss and list the conditions for a healthy rainforest

d) discuss and list the conditions for healthy coral.

Students may use library or computer resources to support their thinking and will share their findings after 10-15 minutes.

STEP 1: View the trailer for Disneynature **DOLPHIN REEF** at https://www.youtube.com/watch?v=RHOMtdA7Q7U. Share with students how precious and rare coral reefs are, given that they cover less than 1% of the ocean floor but are home to 25% of all ocean species. Remind students that although the dolphins seen in the trailer do not inhabit the coral reef, they may live near them, and the reefs are important to their survival. Some species of dolphin hunt for food near coral reefs, and they can give birth and raise their young near this important ecosystem. A healthy, balanced coral reef is critical to the well-being of all ocean species.

STEP 2: Discuss the serious threats that coral reefs face as 20 new coral species were added as threatened species to the Endangered Species Act in 2014, joining the Caribbean staghorn and elkhorn corals, which were identified as threatened in 2006. Coral reefs are threatened by both natural occurrences such as hurricanes, typhoons and disease, and human caused occurrences such as pollution, overfishing and destructive fishing practices, coastal inhabitation, tourism and warming ocean temperatures. Ask students what solutions they can think of to address these issues. What are ways in which individuals can collectively contribute together to solve great challenges? Inform students they will need to have a strong understanding of where coral reefs are located to be better informed on the species.

STEP 3: Ask students to hypothesize what parts of the world may have been locations for the filming of Disneynature **DOLPHIN REEF**. Ask them to recall any clues

Coral Reefs — Maintaining Healthy Ocean Life

that may help them "locate" the geography of the film. View Google Earth-Oceans or sites such as http://wriorg.s3.amazonaws.com/s3fs-public/Regions_web_high-res.jpg to locate places on earth where coral reefs are located.

STEP 4: Distribute *Activity Sheet 1: World Map*. Ask students to use one of the resources above to locate coral reefs around the world. Give students a couple of minutes to locate the many places with coral reef presence. Invite students to make generalizations about the location of coral reefs (near coastlines, centered in the warmer parts on earth). Ask them if their hypotheses about where coral reefs are located was accurate. Seek questions from students and ask if there are any coral reefs located near the United States. Help them to think beyond the 48 contiguous states, to Hawaii, and to territories such as Puerto Rico, Guam and American Samoa. Next, students will use map pencils to highlight the location of coral reefs on their world maps.

STEP 1: Explain that coral reefs are critical to ocean balance and health. The coral reef may be understood as a community that works together for the benefit of all. Specifically, the coral reef structure provides food and shelter for about 25% of species that live in the sea. Corals produce nutrients which serve as a major food source. Algae grows on the coral, and a symbiotic relationship occurs, which helps the reef structure provide the flow of nutrients and clean water. This cycle serves all ocean life, from the tiniest algae to the largest sharks, dolphins and whales. Inhabitants of—and visitors to—a coral reef may partake of shelter. Indeed, many animals rely upon the warm waters surrounding coral reefs to reproduce and raise their young. Without this rich food source and protected area, many fish would not survive. Other species could be affected by unhealthy coral reefs, including dolphins.

STEP 2: Students will use their observation skills to examine three types of coral reefs. Distribute *Activity Sheet 2: Photo Analysis* to each group. Explain that a) first they will observe and write broad statements about the photographs, b) then they will examine sections of the photographs to find more detail, c) next they will list what they see in groups of plant life, animal life and other, and d) finally, they will make inferences and develop questions.

STEP 3: Distribute *Activity Sheet 3: Coral Reef Photos for Analysis*, which features photographs of healthy, unhealthy and transitional coral reefs to groups of students, making sure that each group receives at least one photograph from each category. Ask students to work together in peer pairs to complete *Activity Sheet 2*. Once students have completed their analysis, discuss the findings, going through each of the steps of the photograph analysis.

STEP 4: Explain to students that healthy can mean balanced and thriving; unhealthy can mean sick, dying or dead; and transitional can mean improving or declining in health and balance. Ask students to classify their photographs into these three categories (healthy, unhealthy and transitional) and write reasons for their classification. On three large charts in the classroom have students place their photographs into these categories. (Answers: Healthy—3, 4 and 8; Unhealthy—1, 5 and 9: Transitional—2, 6 and 7)

STEP 5: Distribute two colors of sticky notes—one color for reasons for classification and one color for questions. Ask students to move from chart to chart, to observe the photographs and to write reasons for classification and questions.

Wrap Up

Once all students have classified the photos using their sticky notes, note the vastly different types of coral, animal life and other elements that are represented in each category. Were there disputes among categories? Could a photograph fit into more than one category? Have students talk about these disputes. Remind students that scientists use many sources in order to observe, make inferences or hypotheses, form questions, draw conclusions and plan action.

Determining the Health of a Coral Reef

Extension: Mathematics (Grades 4–6)

*Enrich students' insights into the unique characteristics of animals from Disneynature **DOLPHIN REEF** with extension activities from different content areas.*

How do scientists determine the health of a coral reef? Over the last three decades, outbreaks of coral bleaching and disease have resulted in global reductions in coral reef diversity and resilience. As such, assessments of coral condition are a metric of coral health and have the potential to identify possible causes of changes in the ecological region at the lowest level of the ocean containing the coral reef, including the sediment surface and some sub-surface layers.

Size-class distribution, or coral demographics, is important because it can serve as a telling indicator of disturbance on a reef. For example, a distribution in which an abundance of corals occur within large size classes (>50 cm) suggests a region in which disturbance events have not interfered with the growth of corals over long periods of time. Conversely, a distribution in which the majority of corals occur within small size classes (<10 cm) suggests either a recent, severe disturbance or frequent recurrences of moderate disturbance, after which recruitment and growth have been relatively recent processes.

Coral Reefs — Maintaining Healthy Ocean Life

Also, the condition of the coral (whether bleached or colorful) indicates the health of the coral community.

Scientists use a variety of methods for collecting data on coral reefs. One of the methods used in conjunction with other methods is called a Permanent Photo Quadrat. Divers mark off a 2-meter by 2-meter square area of the coral reef and divide this area into four one-meter squares. A special camera takes close up photos of each of the four squares and these photos are then analyzed in the lab on land. Each photo is divided into 16 squares (4 by 4) and each of these smaller squares are analyzed in detail to determine sizes and health of each coral species in that quadrat. The quadrat is then monitored every six months over several years to determine the changes in the health of the coral reef.

Warm Up

Ask students how scientists might determine the number, size and condition of different corals in a coral reef. Is it possible that scientists swim down to the reef and count every single coral they can see? Ask them how long they think that might take for one of the coral reefs they have been studying? (Several years and the corals could be damaged or dead by the time they had counted them all!) Explain that we can use a systematic sampling technique to make an estimate of how many of each type of coral are present on the reef and the coral's condition.

STEP 1: Students will simulate the analysis of a coral count by using dried beans to represent corals of different sizes and different colors. The white beans will represent bleached coral.

STEP 2: Mark off a 2-meter x 2-meter square on your classroom floor using masking tape. Have students mark half-meter distances along each side of the square. (If your classroom is too small to use a 2-meter x 2-meter square then use a 1-meter square and divide into 16 squares of 25 cm on each edge.) Have students create the 16 squares by using masking tape to join opposite marks across the opposite sides of the large square.

STEP 3: Scatter the bags of dried beans over the whole big square, making sure there are mixtures of beans in each of the 16 small squares.

STEP 4: Distribute *Activity Sheet 4: Dried Beans Record Sheet* to each group of students. Explain to students that each group will be given one of the 16 squares to analyze. The students need to count the number of each type of bean in their square and record these counts on their record sheet. Note: Students will need to measure one of each type of bean using the centimeter rulers to determine if it is "large" or "small".

STEP 5: Bring the groups together and record the numbers from each group on *Activity Sheet 5: Master Record Sheet.* Note this can be done in front of the whole class on a white board or flip board. Have each member of the class calculate the average number of each type of bean based on the numbers from each group. For example, if there are 6 groups, then the average for each type of bean will be the total sum for that bean from the six groups divided by 6.

STEP 6: Have students estimate the total number of each type of bean in the large square by multiplying each of the averages by 16 (the number of small squares that were sampled). Write these numbers on the Master Record Sheet. Remind students that the white beans represent bleached coral (unhealthy), the small colored beans represent stunted coral growth (also unhealthy) and the large colored beans represent healthy coral. Have students discuss what they can deduce about the health of the coral reef represented by the beans scattered on the floor of their classroom. What can they do to help protect the reefs?

Rebuilding Coral Reefs with Art

Extension: Art (Grades 2–3)

*Enrich students' insights into the unique characteristics of animals from Disneynature **DOLPHIN REEF** with extension activities from different content areas.*

Warm Up

Ask students to think about places they have seen statues on display (e.g., art gallery, city garden, museum, etc). What are the types of statues they have seen or know about (e.g., historical figures, athletes, coaches, children)? What type of materials are statues made from (marble, plaster,

Lesson 3

Coral Reefs — Maintaining Healthy Ocean Life

ceramics, wood, bronze, etc.)? Invite a few students to assume statue-like poses and ask the rest of the group to discuss why someone might want to place the statues in the shallow, tropical waters of the ocean. Remind students that coral reefs are threatened throughout the world and are need of conservation action in order to reverse their decline. Many scientists and organizations are working to create artificial reefs in order to help restore ailing coral populations. Some passionate individuals are getting creative with their efforts.

STEP 1: Explain to the class that much of the ocean floor is too unstable to support a reef, so people like Jason deCaires Taylor have created artificial reefs—statues placed anywhere from four to nine meters underwater—to encourage ecosystems to take hold and flourish. The statues are almost as diverse as the ecosystems they hope to foster. Some, like The Silent Evolution or Vicissitudes, depict groups of people standing, some looking toward the sky, some gazing down at the ocean floor. Others, like Un-Still Life (off the coast of Grenada), show inanimate objects—a table, a pitcher, a few stones—are waiting to be reclaimed by nature. Ask students to think of the type of imagery they would create if creating an artificial reef to be placed underwater? Would there be a message they were trying to convey? If so, what?

STEP 2: After watching Disneynature **DOLPHIN REEF** or clips, ask students what they noticed about the coral shown in the movie and discuss what makes for healthy coral. Discuss coral bleaching and how artificial reef creation is used to restore healthy corals

STEP 3: Look at the works of artist Jason deCaires Taylor http://www.underwatersculpture.com/sculptures/. He creates sculptures to help promote reef growth. Discuss and ask questions about his artwork:

- What are the first things you notice about the artwork?
- What do you feel when you look at this artwork?
- What is unique about his process for making artwork?
- What do you think about placing artwork in the ocean?
- What other artists can you think of that present their artwork in nature? (Dale Chihuly, Andy Goldsworthy, Maya Lin)
- What do you think an artist needs to consider about the environment when placing their artwork in nature?

STEP 4: Students will plan their own underwater sculptures inspired by the artwork of Jason deCaires Taylor. Distribute paper and pencils and have students sketch their own ideas for creating some type of underwater installation. Express the critical consideration of using materials that are safe for the environment.

Provide a few ideas of what they might create:

- create a smaller version of a coral reef
- create your favorite sea creature from the film
- create an imaginary object or favorite real object
- create a scene of your favorite activity

STEP 5: Students will create their own underwater sculptures. Using a clay-like material (earthenware, claycrete paper maché mix, or plasticine) and the sketch of their idea, students create a maquette (a smaller version) of their underwater sculpture idea. Students can use any of the three hand building techniques. For example, students can use these three techniques to build their own coral reef: pinch (to create barnacles and coral polyp shapes; coil (to create Staghorn coral or Pillar coral); slab (to create Mushroom coral or Flat coral).

Visit https://www.youtube.com/watch?v=DCElhELPqno for artistic slab, coil and pinch hand building techniques.

WEB RESOURCES

http://www.reef.org/programs/volunteersurvey

You Tube — Exploring the Coral Reef: Learn about Oceans for Kids, FreeSchool. 9:21 https://www.youtube.com/watch?v=J2BKd5e15Jc

Smithsonian Ocean Portal: Find Your Blue — Corals and Coral Reefs http://ocean.si.edu/corals-and-coral-reefs

Diversity of a Coral Reef http://biodiversitya-z.org/content/warm-water-coral-reef

Reclaiming Reefs http://www.reefresilience.org/coral-reefs/management-strategies/ecological-restoration/restoration-of-coral-reefs/

Incredible underwater sculptures from around the world http://www.ba-bamail.com/content.aspx?emailid=10669

BOOKS

Chin, Jason. Coral Reefs. (2011). New York City, NY: Flash Point, an imprint of Roaring Brook Press. ISBN: 978-1596435636

de La Bedoyere, Camilla. 100 Facts-Coral Reef. (2015). Essex, UK: Miles Kelly Publishers. ISBN: 978-1848102729

Holing, Dwight. The Secrets of Coral Reefs: Crowded Kingdom of the Bizarre and the Beautiful (Jean-Michel Cousteau Presents), 2nd Edition. (2005). Montrose, CA: London Town Press. ISBN: 978-0976613435

Sheppard, Anne. Coral Reefs: Secret Cities of the Sea. (2015). London: National History Museum. ISBN: 978-0565093563

Simon, Seymour. Coral Reefs. (2013). New York City, NY: Harper, an imprint of Harper Collins Publishers. ISBN: 978-0061914966

Disneynature DOLPHIN REEF

ACTIVITY SHEET 1

World Map

DIRECTIONS: Mark the locations of coral reefs.

3

ACTIVITY SHEET 2

Photo Analysis

Photo # ____________ Name ________________________________ Date ________________________________

Step 1: General Observation

Observe the photograph for 2 minutes. What is your overall impression of the photograph?

Step 2: Closer Examination

Next, divide the photo into quadrants and study each section to see what new details become visible. Use the chart below to list plant life, animal life and other miscellaneous features in the photograph.

Quadrant 1	Quadrant 2
Plant Life:	Plant Life:
Animal Life:	Animal Life:
Other:	Other:
Quadrant 3	**Quadrant 4**
Plant Life:	Plant Life:
Animal Life:	Animal Life:
Other:	Other:

Step 3: Inference

Based on what you have observed above, list 3 things you might infer from this photograph:

Step 4: Questions

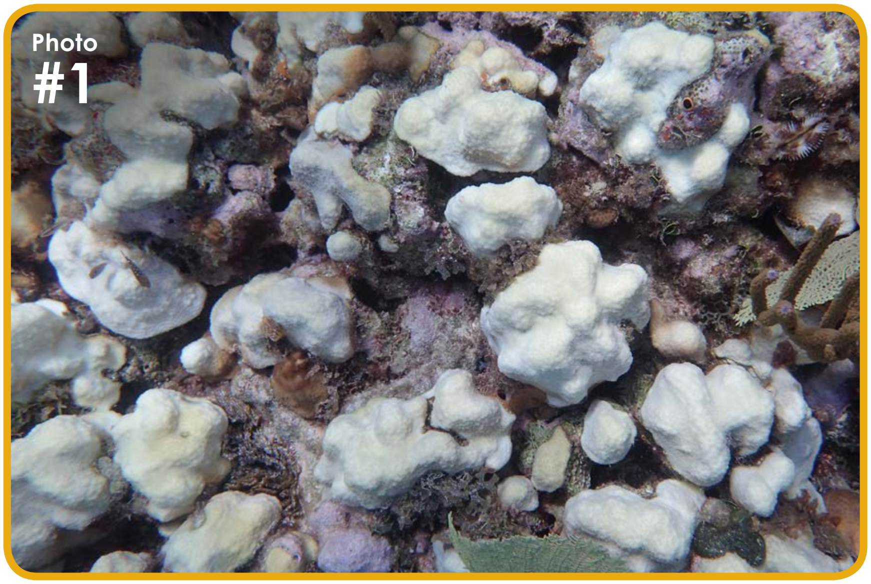
A. What questions does this photograph raise in your mind?

B. Where could you find answers to these questions raised?

3

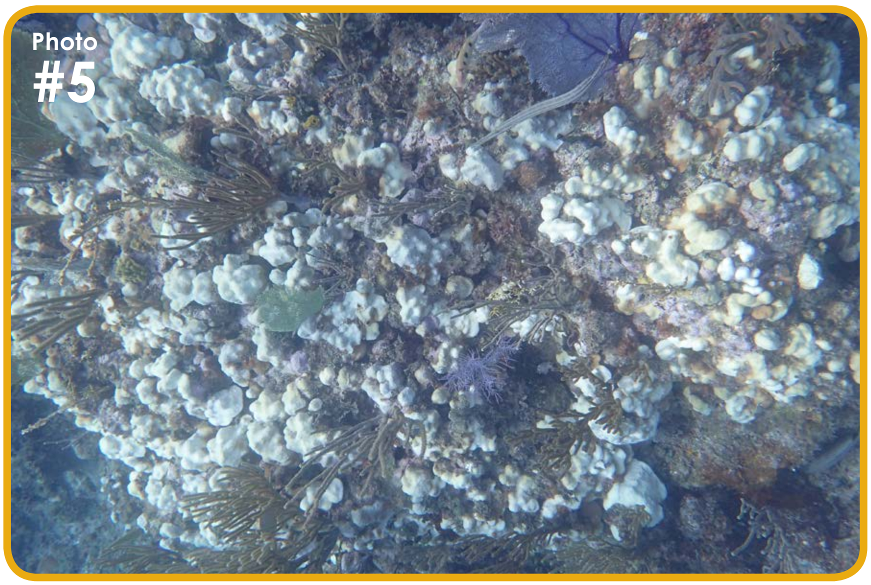
ACTIVITY SHEET 3a

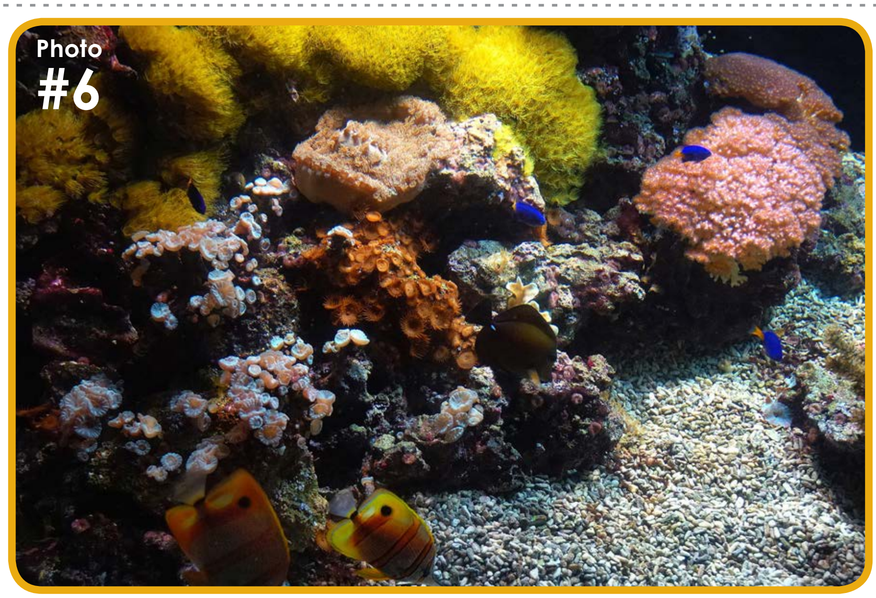
Coral Reef Photos For Analysis



ACTIVITY SHEET 3b

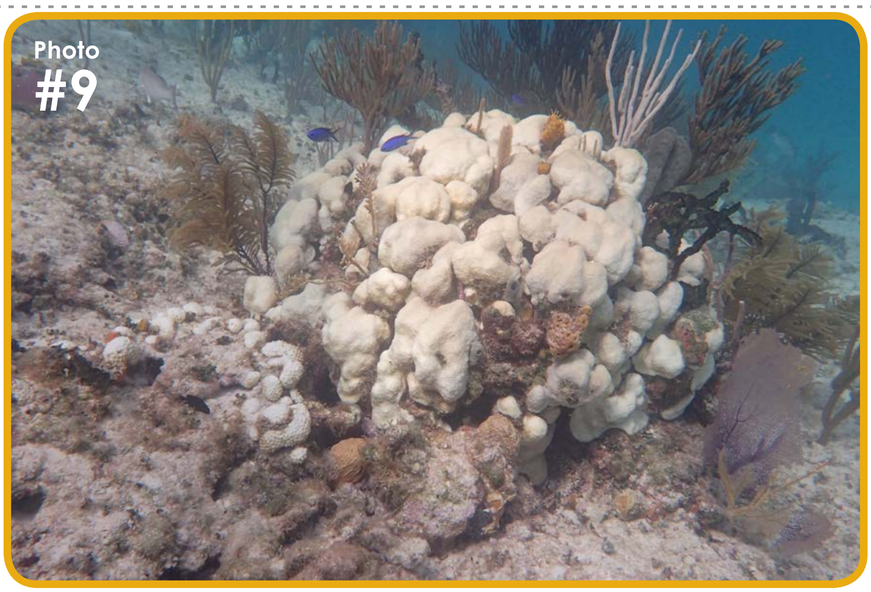
Coral Reef Photos For Analysis





ACTIVITY SHEET 3c

Coral Reef Photos For Analysis



3

ACTIVITY SHEET 4

Dried Beans Record Sheet

Disneynature DOLPHIN REEF

Group ______________________ Date ______________________

White Beans	Large Colored Beans (length is greater than or equal to 1.5 cm)	Small Colored Beans (length is less than 1.5 cm)

ACTIVITY SHEET 5

Master Record Sheet for Classroom Simulation

	White Beans	Large Colored Beans (length is greater than or equal to 1.5 cm)	Small Colored Beans (length is less than 1.5 cm)
Group A			
Group B			
Group C			
Group D			
Group E			
Group F			
TOTALS			

Number of groups ________

Average for all groups ________

Number of squares in the whole grid (16) ________

Estimated totals for the whole grid ________

Lesson 4

SUBJECT:
Focus: Language Arts, Science & Social Studies

Extension: Social Studies

GRADE: 4-6

BACKGROUND INFORMATION:
Animal Glossary, pages 15-19

VOCABULARY:
adaptation, analogy, biomimicry, bioengineering, designer, engineer, emulate, prototype

STUDENTS WILL BE ABLE TO...
- Identify fields that benefit from biomimicry inventions.
- Match stages of the biomimicry process with representative photographs.
- Analyze a biomimicry mind map example that traces the "Need to Nature" process.
- Create a biomimicry "Nature to Need" mind map for an ocean organism.
- Follow biomimicry process to design and build a model of an ocean-inspired invention.

WHAT YOU'LL NEED:
- *Activity Sheet 1: Biomimicry Ocean Life Chain of Connections*
- *Activity Sheet 2a: Biomimicry — Sort and Fill-In Images*
- *Activity Sheet 2b: Biomimicry — Sort and Fill-In Board*
- *Activity Sheet 2c: Biomimicry — Sort and Fill-In Answer Key*
- *Activity Sheet 3: Mind Map of "Need to Nature" Biomimicry Process*
- Crayons
- Glue
- Markers
- Pencils
- Recycled materials

Biomimicry

Innovation Inspired By Nature (Grades 4–6)

Warm Up

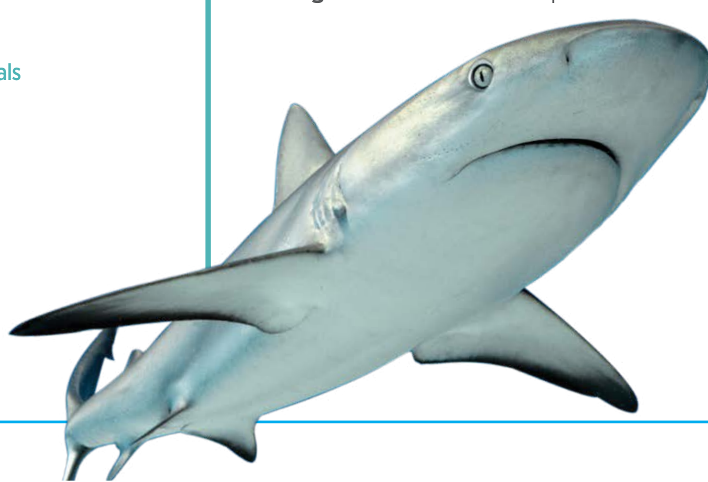
Explain to students that whether they are taking a walk in a forest, swimming in the ocean or simply looking out a window, there are always opportunities for them to notice something in nature that might inspire an idea for innovation. Share with students that the term **biomimicry** means the imitation of natural biological designs or processes used in engineering or inventions. Show a clip of a shark swimming through the water. Provide students with a closer look by showing them a microscopic view of a shark's scales by visiting http://ocean.si.edu/ocean-photos/biomimicry-shark-denticles. Students might make note of the unique shapes of the scales which resemble the shape of teeth. Inform students this unique shape decreases drag and turbulence so the shark can swim faster. Invite students to brainstorm how this discovery might provide benefits to innovation. For example, Olympic swimsuits can be created with similar micro-fabrics in the shape of a shark's scales to improve swim speeds. This practice of observing nature and finding opportunities for improvement is called the "nature to need" process.

Ask students what type of questions they might want to explore to kick off this type of "nature to need" process for a shark. Discuss and then add to their responses: How might a foldable sail be attached to a person? What is the most effective mechanism that could shift the sail shape of a kite into that of a parachute? What type of material would be flexible and yet sturdy? What are flying squirrels' soaring techniques that allow them to adjust the speed and direction of their trajectory and landing? Remind students that if they were engineers, using a biomimicry design process, they would also be thinking about what specific need a new invention might meet.

STEP 1: Explain to students that a growing number of **engineers**, scientists and **designers** use a biomimicry process to draw inspiration from nature to find innovative ways to address needs. Distribute *Activity Sheet 1: Biomimicry Ocean Life Chain of Connections* to each student. Remind the class that in Disneynature **DOLPHIN REEF**, dozens of species are featured that may have the potential to inspire **bioengineered** solutions to problems that humans face. Go over each of the connection chains on *Activity Sheet 1:*

1. *Organism*: identify the life form;
2. ***Adaptation***/Analysis: how does the adaptation function within the environment;
3. *Need/Invention*: application function to the design of the invention;
4. *Fields*: which fields of study may benefit from the invention?

Complete the first row together as a class. Remind students that they may use fields from the word bank more than once if needed. Once complete, students should be prepared to discuss their decisions.



Disneynature DOLPHIN REEF

Biomimicry — Innovation Inspired By Nature

STEP 2: Ask students to read each "Nature to Need" Chain of Connections and label the field(s) that have benefited from the inventions. Guide a large group discussion allowing students to compare their answers. Discuss why there might be differences of opinion.

STEP 3: Arrange the class into pairs. Distribute *Activity Sheet 2a: Biomimicry — Sort and Fill-in Images* and *Activity Sheet 2b: Biomimicry — Sort and Fill-in Board*. Students cut out the pictures on *Activity Sheet 2a*. Next, students glue each picture under the correct part of the biomimicry process on *Activity Sheet 2b*. Students should fill in a one-line description for each part of the process 1) *Name*; 2) *Adaptation*; 3) *Adaptation Analysis*; 4) *Buildable Design*; 5) *Invention/Application*. If needed, provide students with time to conduct research to help describe each part of the process. Finally, ask students in each small group to share their activity sheets and explain what they have discovered about the biomimicry process. What questions do they have?

STEP 4: Distribute *Activity Sheet 3: Mind Map of "Need to Nature" Biomimicry Process*. Examine the mind map while sharing an example of biomimicry. Describe the following steps of how an inventor designed a lamp shade that allowed the user to change the intensity of the shading level to suit different needs. Guide a discussion to help students walk through the steps in the process.

1. The inventor began by considering a small range of shade **analogies** in nature.
2. Next, she focused on the notion of eyelids. Sketching differences in eyelid shape and function helped her decide which nature analogy to use.
3. She studied the eyelids of frogs more closely and chose to **emulate** the frog's three eyelids in the design of a lamp.
4. She determined what structure and materials might result in an invention that allowed different intensities or levels of shading.
5. She sketched a design for the next step—prototyping and modeling the lamp.

STEP 5: After students have finished discussing the mind map, ask them what decisions still need to be made. What's missing from the mind map at this point? (e.g., possible dimensions; measurement notations; optimal colors; suggesting style of pre-made lamp bases that are most supportive of the design; the mechanism for switching shades, etc.) Brainstorm a list on the board of ocean animals that were featured in Disneynature **DOLPHIN REEF**: coral, mantis shrimp, tiger shark, orca, humpback whale, bottlenose dolphin, grey reef shark, hawksbill sea turtle. Distribute markers, crayons and drawing paper to the class. Ask students to select one of the species featured on the board. After students have made a selection, inform the class they will be using the same mind map process to illustrate how they would connect a chain of thinking on a mind map from a) "Nature to Need" or b) a "Need to Nature" idea. Students may work individually or in peer pairs. Tell students that either process allows them to dig deeper into the design of an adaptation of the ocean animal they selected, and also to imagine how they might use the design to emulate nature's solution to meet a need. Provide students with extra time to research design solutions on the Internet, at home or in class.

STEP 6: After completing the chain of thinking for their mind map, invite students to make **prototypes** or models of their inventions using recycled materials. Ask students why scientists, engineers or artists might make models/sculptures of things. Ask them to take the perspective of an engineer who might make a model to better understand how an adaptation works because they want to use it to solve a human problem (this connects to the lesson on the concept of biomimicry).

STEP 7: Have a "Makers" or "Inventors" fair to display and present the prototypes. Make sure that students' explanations of their biomimicry journey include the processes they used in creating their application from nature. Students may also choose one need (such as eating or catching prey) to highlight. Students should share the adaptation from each animal that meets a specific need. For example, the mantis shrimp has an adaptation of its powerful claw being able to punch or club and stun its prey, while the cone snail has harpoon-like teeth that it can shoot at prey to inject venom. In this way, students are able to compare and contrast each animal and how different adaptations meet similar needs.

Wrap Up

Invite students to reflect on the benefits of biomimicry and the processes involved in bringing an idea from concept to invention. Which fields of study do students think produce the most bio-inspired inventions?

Lesson 4

Biomimicry — Innovation Inspired By Nature

Futurecasting

Extension: Social Studies (Grades 4–6)

*Enrich students' insights into the unique characteristics of animals from Disneynature **DOLPHIN REEF** with extension activities from different content areas.*

STEP 1: Invite students to "futurecast" or predict how their own view of the world might be different as a result of a nature-inspired invention. This futurecasting activity is based on thinking ahead and anticipating a chain of events within relevant cultural and social areas (sustainable energy, economics, medicine, education, transportation, communication, etc.) Students may select one of the inventions listed on *Activity Sheet 1: Biomimicry Ocean Life Chain of Connections*, or they may select a new nature-inspired invention and conduct online research.

STEP 2: Students will write a three-paragraph essay and draw an illustration of how an invention might affect their own future life on earth and explain why. Papers should include:

1. *The Invention*: name and description of the invention;
2. *Purpose*: explanation of the need or intended purpose of the invention;
3. *Chain of Changes:* list the changes that might result;
4. *Prediction*: how the predicted vision improves your life and makes you feel. What is different in your own life now? Why is it better?

Provide the example of "Green" Energy Solutions to guide students' thinking. Then invite them to briefly discuss possible effects for one or two other inventions. Consider these other Green Energy Solutions:

- filtering of water based on oysters and mussels filtration;
- ocean current electricity generator based on kelp beds;
- wind turbine blades inspired by bumps on the fins of whales.

Wrap Up

Ask students to share their completed futurecasts and lead a group discussion on what common themes arose in each prediction of nature-inspired biomimicry inventions.

"GREEN" ENERGY SOLUTIONS EXAMPLE:

Sea Fan Energy Futurecast

The future could be improved through the use of Sea Fan Energy Turbines. Harnessing ocean wave energy with sea fan inspired turbines is hoped to make an affordable, sustainable source of energy.

This invention might result in removing the need to burn coal or run nuclear plants to produce energy = which results in less expensive costs to consumers = which also results in better air quality and a cleaner environment = which results in better health for many people.

This vision of the future makes me feel optimistic. Currently, coal and fossil fuels create pollution and my city has bad air quality. Green energy solutions would help us breathe better and maybe even live longer.

RESOURCES

For teachers:

Allen, Robert. Bulletproof Feathers: How Science Uses Nature's Secrets to Design Cutting-Edge Technology. 2010. Chicago, IL: University of Chicago Press. ISBN-13: 978-0226014708

https://www.teachengineering.org/lessons/view/duk_surfacetensionunit_less4

http://teachers.egfi-k12.org/tag/biomimicry/

http://www.greeneducationfoundation.org/institute/lesson-clearinghouse/457-Biomimicry-The-Genius-of-Nature.html

https://www.epo.org/learning-events/european-inventor/finalists/2018/dewar.html

For students:

Gates, Phil. Nature Got There First: Inventions Inspired by Nature. 2010. NY: Kingfishter. ISBN-13: 978-0753464106

Lee, Dora. Biomimicry: Inventions Inspired by Nature, 2011, Tonawanda, NY: Kids Can Press. ISBN 978-1-55453-467-8

http://www.bloomberg.com/news/photo-essays/2015-02-23/14-smart-inventions-inspired-by-nature-biomimicry

ACTIVITY SHEET 1

Biomimicry Ocean Life Chain of Connections

Name ______________________________ Date ______________________________

DIRECTIONS: Read each "Nature to Need" Chain of Connections and list the field(s) of study that benefits from the invention.

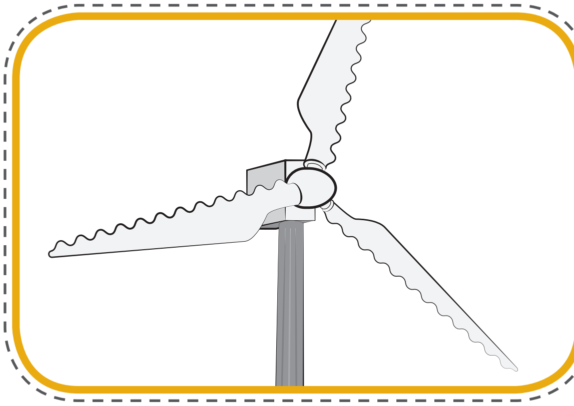
Organism	Adaptation/Analysis	Need/Invention	Fields of Study
Shark	Grooved scales on skin cause water to flow more easily	Swimsuit fabric for faster racing	Textiles, Sports
Mussel	Sticks to slippery spaces underwater	Underwater glue	
Nautilus	Spiraling geometric pattern on shell	Exhaust fans move air easier through vents	
Boxfish	Aerodynamic shape allows for fluid movement with less resistance	Car design for energy saving movement	
Kelp	Anchored sea plant moves naturally with currents or waves	Produce energy from underwater windmills to harness energy of water in motion	
Herring	Tissue stays healthy in cold water	New ways to freeze tissue while keeping it healthy	
Sea urchin	Self-sharpening spines can cut through stone	Tools that don't need to be sharpened	
Orca	Acute hearing and sensing of sounds, as well as sonar	Ultra-sensitive underwater microphone	
Octopus	Sensors on skin help to camouflage and mimic surroundings	Camouflaging flexible materials with photo sensors and temperature-sensitive dye that changes colors or patterns	
Sea lion	Flipper shape results in powerful and agile swimming	Super stealth and maneuverable submarines	

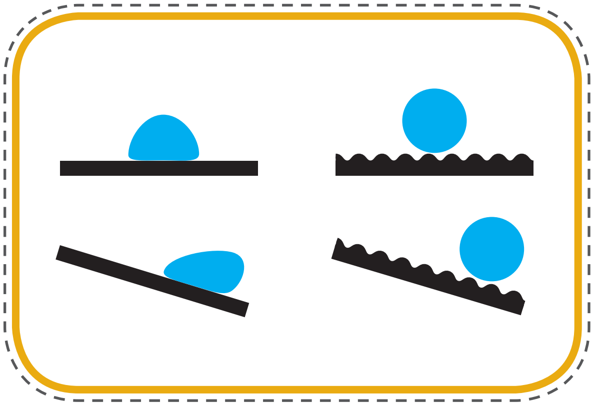
Fields of Study

MEDICINE
ENERGY SAVINGS
FURNITURE
TRANSPORTATION
AIR CONDITIONING
TEXTILES
ENERGY PRODUCTION
BOATING
SPORTS
RESEARCH
SUSTAINABLE SOLUTIONS
ARCHITECTURE
MILITARY DEFENSE
WILDLIFE PHOTOGRAPHY
INDUSTRY
CONSTRUCTION
CLOTHING
TOYS
ENTERTAINMENT
EDUCATION
OTHER____________________

ACTIVITY SHEET 2a

Biomimicry — Sort and Fill in Images





ACTIVITY SHEET 2b

Biomimicry — Sort and Fill-In Board

Name ______________________________

Date ______________________________

1) Name:

2) Adaptation:

3) Adaptation Analysis:

4) Buildable Design:

5) Invention/Application:

4

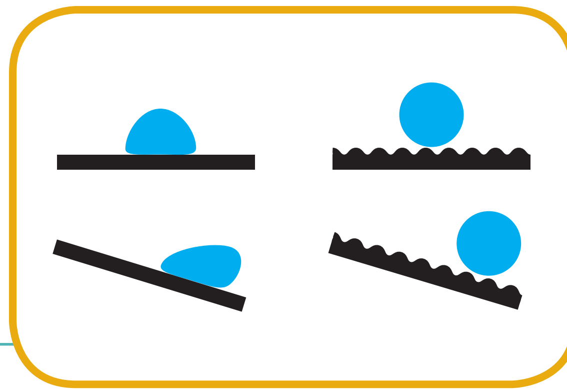
ACTIVITY SHEET 2c

Biomimicry — Sort and Fill-In Answer Key

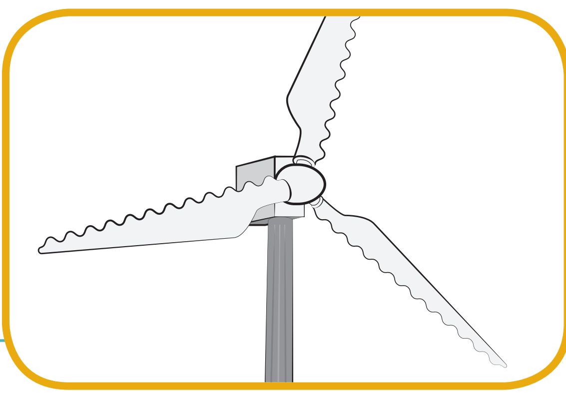
1) Name:
Humpback Whale

2) Adaptation:
Agility

3) Adaptation Analysis:
Tubercles (bumps) on the flippers channel water flow and allow for more aerodynamic swimming



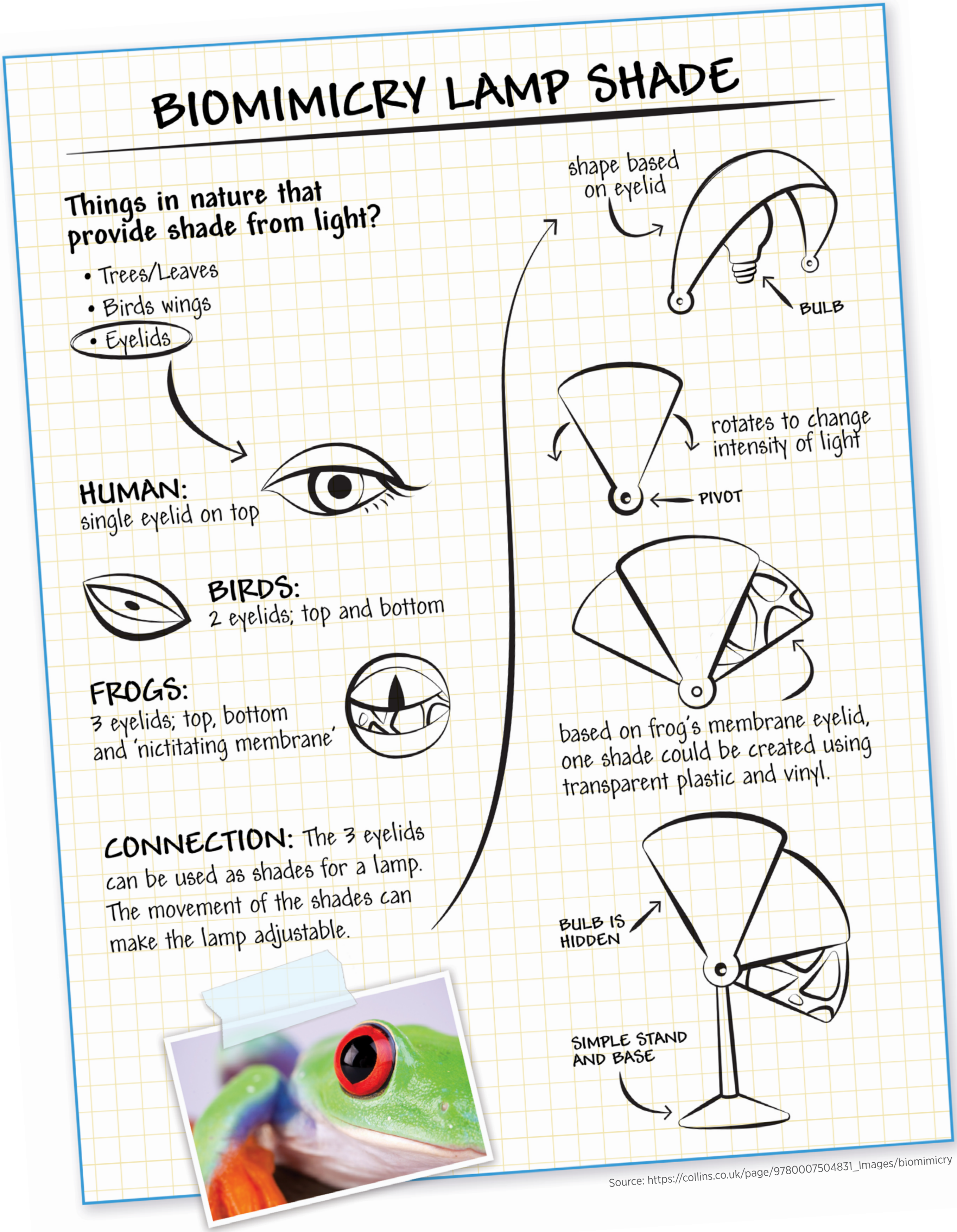
4) Buildable Design:
Water (or wind) is channeled between the bumps



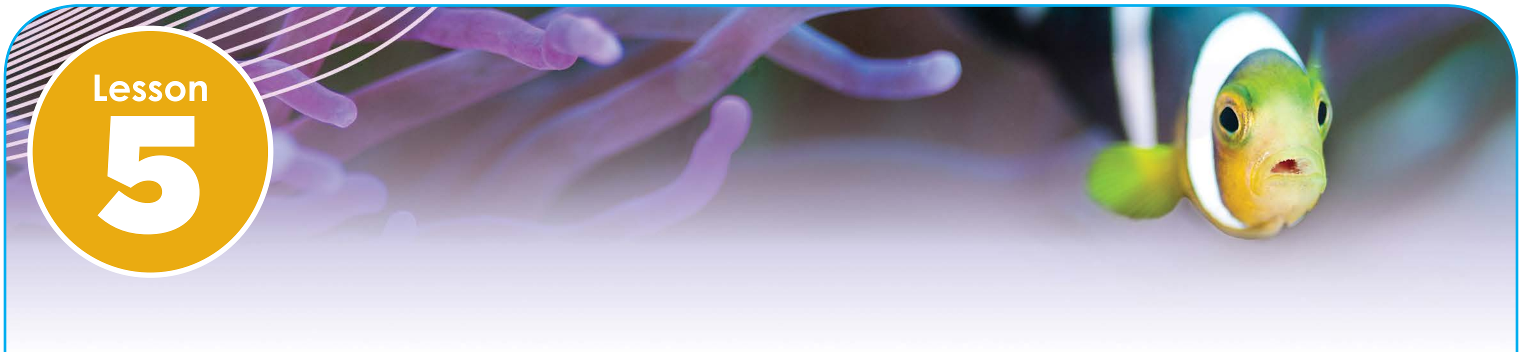
5) Invention/Application:
Wind turbines made more efficient by adding a bumpy outline

ACTIVITY SHEET 3

Mind Map of "Need to Nature" Biomimicry Process



Source: https://collins.co.uk/page/9780007504831_Images/biomimicry



Lesson 5

Small but Mighty

Zooming in on Marine Life (Grades 2–6)

SUBJECT:
Focus: Art, Science, & ELA
Extension: Math

GRADES:
Main Lesson: 2-6
Extension: 4-6

BACKGROUND INFORMATION:
Pages 11-12

STUDENTS WILL BE ABLE TO...
- Observe powerful animal adaptations for four small ocean organisms.
- Design a superhero that has two or three Small but Mighty animal adaptations.
- Produce a superhero adventure that shows adaptations that saved the day.
- Draw a zoom picture book of a Small but Mighty organism and ecosystem.

VOCABULARY:
elusive, function, organism, scale, abstract, adaption

WHAT YOU'LL NEED
- *Activity Sheet 1: Small but Mighty Coral Reef Animals*
- *Activity Sheet 2: Record Table*
- Colored pencils
- *Zoom* by Istvan Banyai (book or link: http://www.slideshare.net/zarthustra7/zoom-by-istvan-banyai-23329406
- Magnifying glasses
- Paper (large enough to be folded into a book and stapled down the middle)
- Pencils
- Rulers
- Calculator

Warm Up (All grade levels)

Ask students to predict which marine animal would win a fight if one was a two-inch-long shrimp and the other a six-inch-long fish or crab. As students share their predictions, keep a tally on the board. Ask students to justify their prediction. Why did they think a fish or crab would beat a shrimp or a shrimp would beat a fish or a crab?

Of the many intriguing ocean animals featured in Disneynature **DOLPHIN REEF**, some that may be overlooked are organisms that are small enough to fit in your hand (or even smaller). These marine animals display some fascinating adaptations that make them mighty minions of the ocean. They also present unique challenges for marine scientists who wish to study them. Because many are very small, they are often elusive, secluding themselves within small niches within coral reefs. Finding and studying these small creatures requires scientist to employ innovative techniques for zooming in or getting up close and personal.

Grades 4-6

STEP 1: Remind students that all animals share basic needs such as: eating, breathing (or taking in oxygen), defense (or protection, or not getting eaten), reproduction (raising young), shelter and the need to interact with their environment. Not all animals meet their needs in the same way. For example, some animals are herbivores (plant eaters) while other animals are carnivores (meat eaters). The way an animal meets these needs is called an **adaptation**. Smaller creatures of the coral reef have some mighty and powerful adaptations that may protect them from predators or equip them to hunt prey.

STEP 2: Share with students that scientists put on SCUBA (Self-Contained Underwater Breathing Apparatus) gear and dive into a small creature's world, bringing with them underwater video cameras and magnifying lenses that allow them to focus on the smallest of details. Some scientists may use Remotely Operated Vehicles (ROV), or carefully constructed underwater marine environments, to observe creatures in their ecosystem. Others may capture a tiny specimen to temporarily place in a saltwater coral reef aquarium in a laboratory for further study. Students will be able to get up close and personal with small but mighty marine animals by studying one of the animals.

STEP 3: Show and discuss with the class, pages of the wordless picture book, *Zoom* by Istvan Banyai, or link to a slide share of the pages: http://www.slideshare.net/zarthustra7/zoom-by-istvan-banyai-23329406. The series of illustrations form a visual puzzle that students are likely to find intriguing. Point out how the details within the focus of the images change as the perspective changes in ever enlarging pictures that tell the story.

STEP 4: Write a list of small but mighty ocean animals on the board:

- mantis shrimp
- sea urchins
- pufferfish
- parrotfish
- decorator crab

Students will be illustrating a zoom book about one of the small but mighty animals. They may work individually or in peer pairs. Explain that their zoom books will range in

Lesson 5

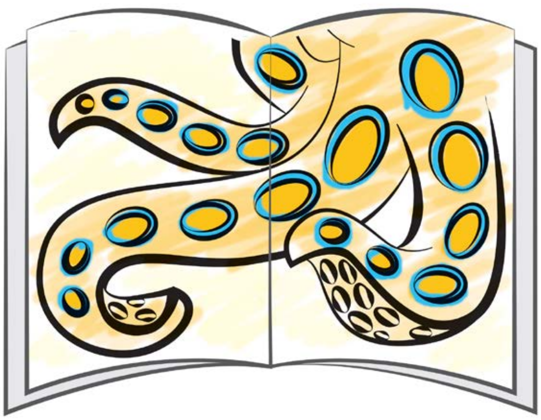
Small but Mighty — Zooming in on Marine Life

focus, beginning with a magnifying glass or microscopic view of an animal detail in the first picture and then zooming out across the next series of pictures to reveal the animal's identity, use of the adaptation and habitat. These wordless picture books will use visual details and cues to highlight small ocean creatures' powerful adaptations.

STEP 5: Ask students to identify which animal they will illustrate in their zoom books. Cut out sets of Information Cards from *Activity Sheet 1: Small but Mighty Coral Reef Animals*, and distribute designated cards to individual or peer pairs of students. Students should use the cards to learn about the organism's unique adaptations, size and see an image of the organism. Invite them to learn more about the animals online, paying close attention to images of habitat, predators, prey and close-ups of adaptations.

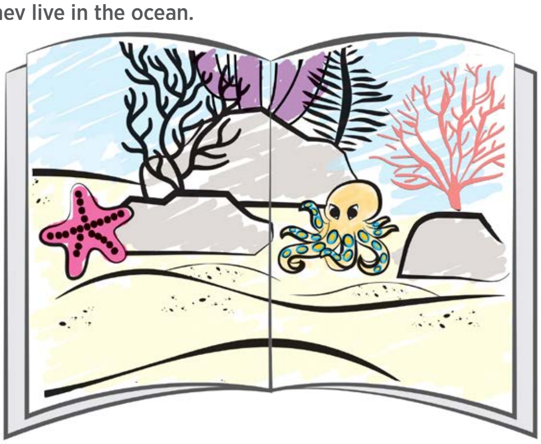
STEP 6: As the word zoom suggests, each of the students' pages will either zoom in or zoom out as they tell the story of their small but mighty animal, similar to the way a camera zooms in on a subject and zooms out from a subject.

1 For the first page of their zoom books, ask students to create a close-up detail of the chosen animal. Zoom in very close so that what is created almost becomes an abstract picture filled with just color, shapes and lines.

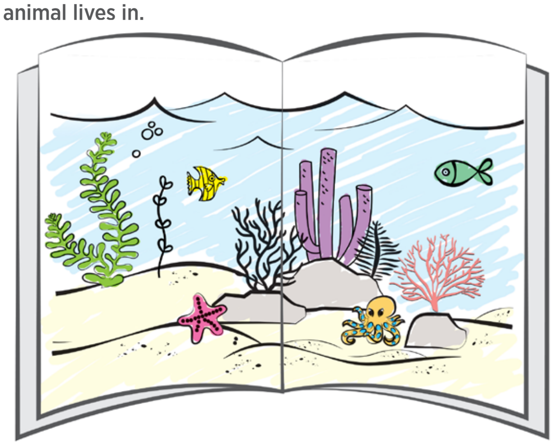


2 On the next page students zoom out to reveal more of the chosen animal. Perhaps now the viewer can tell what kind of creature they are creating.

3 Continue to zoom out on subsequent pages, revealing more and more information about the animal, their adaptations and where they live in the ocean.



4 Students should create as many pages as they need (5 minimum if continuing to the extension) to reveal the whole environment that the animal lives in.



Shown in the example:
Blue-ringed octopuses have a biting beak with powerful and deadly toxins. Their blue rings become iridescent when they are threatened.

Lesson
5

Small but Mighty — Zooming in on Marine Life

Grades 2-3

STEP 1: Brainstorm with students about what makes a superhero super? Which superheroes are their favorites? Why? One thing superheroes have in common is that they have some super ability or combination of abilities that allows them to powerfully solve problems, vanquish enemies and do good deeds. Sometimes inspiration for superhero abilities can be found in the strangest places, including the small but mighty creatures found in Disneynature **DOLPHIN REEF**.

Arrange the class into small groups that will each design a superhero that uses two or three different Small but Mighty animal adaptations. Brainstorm with students adaptations that might be helpful to a superhero:

- Safety or protection (camouflage, armor, poison, etc.)
- Enhanced abilities for getting food (speed, sight, hearing, strength)
- Both (poison can stop a predator or be used by a predator)

STEP 2: Write a list of small marine animals on the board and invite students to recall which type of adaptations could become superhero attributes:

- mantis shrimp
- sea urchins
- pufferfish
- parrotfish
- decorator crab

STEP 3: Refer students to *Activity Sheet 1: Small but Mighty Coral Reef Animals* so they can review specific adaptations. If time permits, students may choose, research, and design a superhero for other sea animals such as: a sea snake, stingray, lionfish, stinging coral, scorpion fish, sea anemone, anglerfish, pinecone fish.

STEP 4: Students in small groups determine which 2-3 animal adaptations they would like their superhero to have and complete the following objectives:

a) Draw sketches of a human superhero who has the selected animal abilities.

b) Students agree on one of the sketches, add superhero colors, label parts of the suit or body and decide on a superhero name.

c) Students write two paragraphs:

1. Describe the superhero;
2. Write a scene about an adventure that shows how the superhero saved the day. Some adventure missions and scenarios might include: an underwater rescue mission; fighting off invasive species or predators; spying on enemies of the reef; sending or taking messages about threats to the reef to a wise whale, etc.

STEP 5: Provide nonfiction books or links to informational web sites for additional inspiration.

a) Students should include cartoon action words (e.g., bang, boom, arghh, pow, etc.) to enhance the story.

Wrap Up

As a whole group, students can share their illustrations with classmates, highlighting how the superhero used animal adaptations to save the day. Discuss how adaptations help small creatures live in powerful and mighty ways within the coral reef environment.

Representation of Scale

Extension: Mathematics (Grades 4–6)

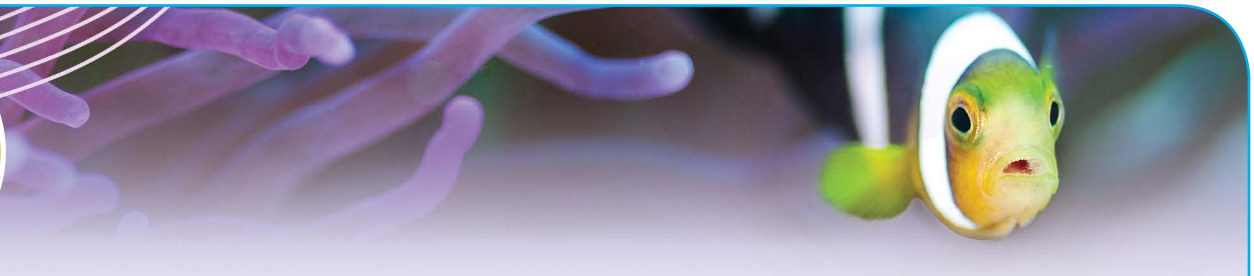
*Enrich students' insights into the unique characteristics of animals from Disneynature **DOLPHIN REEF** with extension activities from different content areas.*

Math Note: This activity assumes that students have already been introduced to the idea of a ratio of two measures and also how to calculate that ratio and represent it in simplest form (usually as a unit fraction or unit proportion).

Mathematically, the scale of the representation of an object is the ratio of the dimensions of the representation to the same dimensions of the real object. In this mathematical extension, students are asked to calculate the scale of each representation of the object in their zoom book to the first, close-up drawing in their book. Scale is usually represented in the form of a metric such as "1 centimeter represents 1 meter" or "Scale = 1:100" meaning that each unit of length in the "scale-drawing" represents 100 of those same units for the real (or represented) object. Knowing the scale of a representation is very important as it allows the viewer or user of the scaled drawing to make predictions about how the represented object relates to other objects in the real (or represented) world.

STEP 1: Ask students to think about how the actual size of each object on each page of their zoom book or on each page of *Zoom* by Istvan Banyai changes. Draw attention to the first nine pages that zoom out from the Rooster's Coxcomb

Disneynature DOLPHIN REEF



Lesson
5

Small but Mighty — Zooming in on Marine Life

to the boy in the deck chair. Each page shows a smaller and smaller drawing of the same object. This perspective shows how the object appears from farther and farther away. Each page is showing a scale drawing of the object on the previous page. Students have probably encountered the notion of “scale” in playing with toys that are replicas of real objects (e.g. toy cars or action figures or even dolls).

STEP 2: Distribute *Activity Sheet 2: Record Table*. Ask students to measure the height or width or some significant part of their first drawing on page one of their zoom book and record this measurement in the cell under **page one**.

Students record the measures of the same part of the same object in each of the next four pages (through page five) of their zoom book in the second row of the table.

STEP 3: In the third row of the table, students need to record the ratio of the measure for each page compared to the measure for page one. They may use a calculator to calculate this ratio. Measure for page xxx divided by measure for page one.

STEP 4: In the fourth-row students should record each ratio as a scale in the form 1: xxx. For instance, if the ratio from page three to page one is 0.25 (as a decimal) then this would be 25/100 as a fraction and 1:4 as a scale ratio. Students may need help expressing a decimal in fraction form and converting that fraction to a unit scale ratio. In some cases, the scale may not be expressed in whole numbers. For instance, if the ratio is 2/7, the scale would be 1:3.5.

STEP 5: Students can use the last three rows of the table to record the scale of their drawing of the same object from one page to the subsequent pages in their book. For example, the fifth row of the table would record the scale of the drawing on pages three, four and five relative to the drawing on page two.

Wrap Up

Ask students to compare the scales they calculated for each page of their zoom book. What do they notice as they get further along in their zoom book (The scale should get smaller and smaller)?

What about the scale for each consecutive pair of pages (e.g. is the scale for page two relative to page one similar to the scale for page three relative to page two?). Students can look at their own table data and pay special attention to the scales recorded in the cells that progress diagonally down from the scale under the page two column down to the last cell in the bottom right-hand corner of their table. Are these scales close to each other or do they change quite a bit? How would these changes relate to how far out you had zoomed your view-point?

WEB RESOURCES

http://www.azosensors.com/news.aspx?newsID=10925

https://www.universityofcalifornia.edu/news/underwater-microscope-provides-new-views-ocean-floor-sea-creatures-their-natural-setting

http://animals.nationalgeographic.com/animals/invertebrates/geographers-cone-snail/

http://www.uwphotographyguide.com/index.php?q=blue-ringed-octopus

http://www.montereybayaquarium.org/animal-guide/invertebrates/decorator-crab

http://a-z-animals.com/animals/puffer-fish/

BOOKS

Banyai, I. (1995). Zoom. New York: Viking / Penguin. ISBN-10: 0140557741

Banyai, I. (1998). Re-Zoom. New York: Viking / Penguin. ISBN-10: 014055694X

Disneynature DOLPHIN REEF

ACTIVITY SHEET 1

Small but Mighty Coral Reef Animals

(Cut out sets of cards to distribute to students or peer pairs)

Mantis Shrimp 2-14 in (5.0-35.5 cm)

ADAPTATION:	FUNCTION OF ADAPTATION:	HABITAT:
Clubbed claws	Smashing or punching prey (clams, crabs and snails) or predator (eels, sharks) with a strike at the speed of a .22 caliber bullet (50 times faster than the blink of an eye)	Crevices of coral and rocks on the ocean floor

Sea Urchin 1.2-3.9 in (9.0-9.9 cm)

ADAPTATION:	FUNCTION OF ADAPTATION:	HABITAT:
Spines	Venomous spines move in direction of predators or prey (fish, brittle stars)	Wedged in shallow water between rocks with spines facing outward

Pufferfish 1 in (2.5 cm)

ADAPTATION:	FUNCTION OF ADAPTATION:	HABITAT:
Elastic stomach expands to hold huge amounts of water and air	Scare predators	Slopes of tropical coral reefs

Parrotfish 12 in (30.4 cm)

ADAPTATION:	FUNCTION OF ADAPTATION:	HABITAT:
Mucus covers body at night. Sharp beak used to eat algae and rock	Mucus hides smell as protection from predators; ground up rock is excreted as sand.	Coral reefs and seagrass beds of tropical oceans

Decorator Crab 2-5 in (5-8 cm)

ADAPTATION:	FUNCTION OF ADAPTATION:	HABITAT:
Velcro-like bristles on shell	Organisms and material stick to shell so it can hide from predators; if the organisms are toxic they can hurt predators.	Live in coral reefs worldwide

ACTIVITY SHEET 2

Record Sheet

Name ______________________ Date ______________________

Title: ______________________

	Page 1	Page 2	Page 3	Page 4	Page 5
Measure					
Ratios					
Scales					
Scales					
Scales					
Scales					

SUBJECT:
Focus: Science & Music
Extensions: Art & ELA

GRADE:
Main lesson: 4-6
Extension: 2-6

BACKGROUND INFORMATION:
Pages 8-9

STUDENTS WILL BE ABLE TO...
- explain basic principles of sound production, transmission and reception.
- relate experiences with sound to scientific and musical properties.
- describe how dolphins and toothed whales locate food.
- describe emotional responses to music.

VOCABULARY:
echo, echolocation, energy, frequency, loudness, pitch, tempo, vibration, waves

WHAT YOU'LL NEED:
(Each Activity Sheet lists materials for specific project)
- Speakers to play audio from https://soundcloud.com/iwhales/gabriel
- *Activity Sheet 1: Sound is Vibration*
- *Activity Sheet 2: Sound Waves Move*
- *Activity Sheet 3: Sound Moves Through Different Materials*
- *Activity Sheet 4: Sounds Can Bounce*
- *Activity Sheet 5: Echolocation Game*

Sounds of the Sea

Sound Stations and Echolocation (Grades 4–6)

Warm Up

Whales sing and dolphins whistle and chatter. These water-dwelling creatures use sound for many purposes, including to communicate. Ask students if they have heard sounds while they were underwater, perhaps at a swimming pool? Ask them to consider how hearing sounds underwater is different from sounds that travel through the air? Invite students to listen to some of the sounds they would hear marine animals make if they lived in the ocean. (Play 10-15 seconds of audio segments from the following site: https://soundcloud.com/iwhales/pleione.

Explain that the Sound Station activities in this lesson will help students explore more about how sound is made, how it travels and how whales and dolphins use echo sounds to communicate and find food.

Part 1: Sound Stations

Ideally, the activities can be arranged in "stations" where small groups or pairs of students rotate through all the activities, completing the activity sheets.

Stations include:

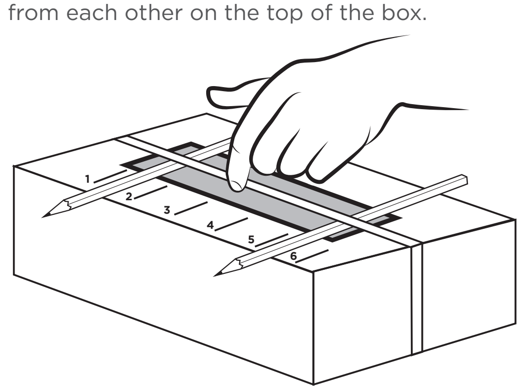
- Sound Station 1: Sound is vibration
- Sound Station 2: Sound waves move
- Sound Station 3: Sound moves through different materials
- Sound Station 4: Sounds can bounce.

SOUND STATION 1:

Sound is Vibration

WHAT YOU'LL NEED:
- Cardboard shoe box or tissue box, with a slot cut in the top of the box. Mark the top of the box with a line every inch to indicate spots for the pencils to be placed. Label the lines to indicate starting points for the pencil locations, and number the other marks so students can record the location of the pencil.
- Rubber band large enough to wrap around the box tightly enough to vibrate but not so tight as to break when plucked.
- Two pencils, longer than the box's width.
- *Activity Sheet 1: Sound is Vibration*

PREPARE THE STATION: Assemble the sound box by wrapping the rubber band lengthwise over the empty shoe box so that it is over the slot cut in the box top. Place two pencils under the rubber band. The pencils should be placed on the marks that are furthest from each other on the top of the box.



Lesson 6

Sounds of the Sea

Lead students to the following conclusions based on their experiences with the Sound Stations:

- Sound is made when an object vibrates.
- The faster it vibrates, the higher the sound.
- The longer the band, the lower the sound; the shorter the band, the higher the sound.
- The harder the band is plucked, the louder the sound. Plucking harder creates more energy in the vibration.

Discuss with students that the highness or lowness of a sound is created by the speed of the vibration. Musicians call the highness or lowness "pitch." Scientists call the differences in highness or lowness "frequency" as a way to describe how fast or slow the object is vibrating. A bottlenose dolphin creates its own frequency through vocalizations. Although they do not have vocal cords, dolphins can create vocalization by releasing air from the blowhole.

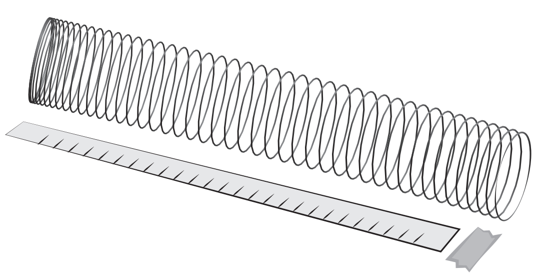
SOUND STATION 2:

Sound Waves Move

WHAT YOU'LL NEED:

- a Slinky
- masking tape
- yard stick
- a smooth, flat surface at least 6 feet long (e.g., a large table, a non-carpeted floor)
- *Activity Sheet 2: Sound Waves Move*

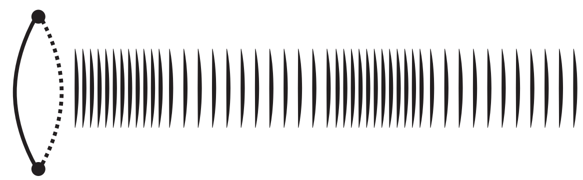
PREPARE THE STATION: Place a Slinky, masking tape, and a yard stick on the designated smooth flat surface.



LEAD STUDENTS TO THE FOLLOWING CONCLUSIONS:

- Sound waves have different amounts of energy, depending on how much energy was used to start the sound wave (the "push").
- Small amounts of energy produce waves that don't travel very far. These kind of sound waves are soft sounds.
- Larger amounts of energy produce waves that can travel longer distances. These kinds of waves are louder sounds.
- When sound waves meet an object in their path, they bounce back (when the wave reached the end of the Slinky, it reversed its direction).

In *Activity Sheet 1,* you made the rubber band vibrate by plucking it, and you heard a sound. The back and forth vibrations in a band create waves in the air because they push the air just like the Slinky moved when it was pushed (see the diagram below). High frequency sounds like chirps and whistles tend to not travel far in water. However, dolphins produce many different sounds, even above the surface of the water. They can include sounds when they jump, or breach, or even when they strike the water surface with flippers and flukes and due to the longer wavelength and greater energy, they can travel farther.



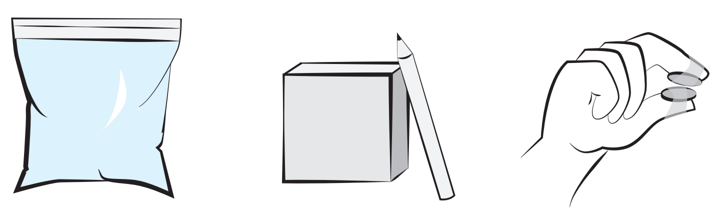
SOUND STATION 3:

Sound Moves Through Different Materials

WHAT YOU'LL NEED:

- A sealed plastic bag, filled with water (make sure the bag is securely sealed).
- A wooden block (4x4 inches, at least ½ inch thick).
- A plastic pen or a wooden pencil.
- Two coins or metal washers.
- Cellophane tape.
- *Activity Sheet 3: Sound Moves Through Different Materials*

PREPARE THE STATION: Fill a resealable plastic bag with water and seal it tightly. Place the bag, wooden block, plastic pen or wooden pencil, two coins/metal washers, and cellophane tape at the station.



Disneynature DOLPHIN REEF

Lesson 6

Sounds of the Sea

LEAD STUDENTS TO THE FOLLOWING CONCLUSIONS:

- Sound can travel through air and other materials like water or wood.
- The materials make the waves sound different.
- Materials that are solid like wood make the sounds seem louder than the same sound in the air.

Materials that are solid, like wood, make the sounds seem louder than the same sound in the air. In water, sound can travel at a speed of about 0.9mi/sec or 1.5km/sec. This is about 4.5 times faster than sound traveling through air.

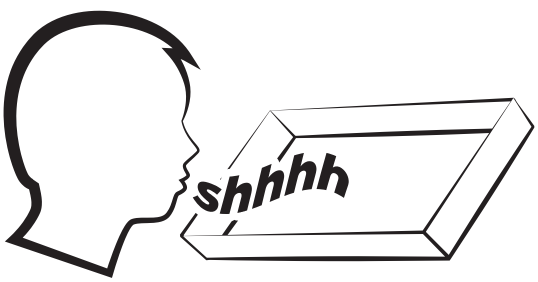
SOUND STATION 4:

Sounds Can Bounce

WHAT YOU'LL NEED:

- A hard plastic or metal tray, such as a tray from a school cafeteria.
- A piece of rubber and a piece of cloth (burlap or a blanket) cut to the size of the inside of the tray.
- *Activity Sheet 4: Sounds Can Bounce*

PREPARE THE STATION: Find or cut a piece of cloth to the size of the inside of a plastic or metal tray. Find or cut a piece of rubber to the size of a plastic or metal tray. Place the rubber, cloth, and tray at the station.



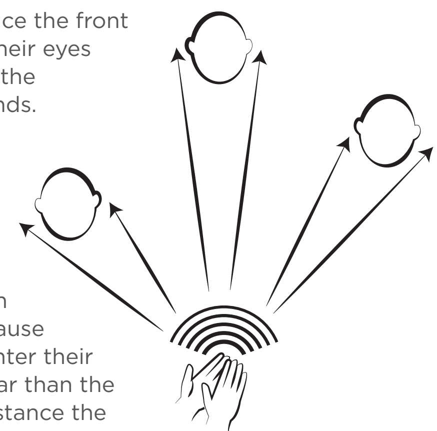
LEAD STUDENTS TO THE FOLLOWING CONCLUSIONS:

- Materials that are hard and smooth cause sound waves to bounce off the object and continue in other directions.
- Materials that are soft or full of bumps and holes cause sound waves to be decreased or stopped. The energy in the sound wave is soaked up, like when a wash cloth wipes up spilled water—the water goes into the cloth.
- Sound waves that bounce off objects can cause an echo when the sound waves return to where they started. An echo sounds like a softer copy of the original sound when it returns to your ears after bouncing off an object.

Provide students with the definition of echolocation. Discuss as a class what animal species can use echolocation as an adaptation. Bottlenose dolphins, like the ones featured in Disneynature **DOLPHIN REEF,** use echolocation to determine the size, shape, speed, distance and direction of objects in the water. This helps them locate food or avoid predators when needed.

Part 2: Echolocation

STEP 1: Have students face the front of the room and close their eyes while you move around the room, clapping your hands. After each clap, ask the students to point to your location. How do they know where you are? Lead them to conclude that they can hear sound coming from different directions because the sound waves that enter their ears are louder in one ear than the other because of the distance the vibrations must travel to their ears.



STEP 2: Watch the trailer for Disneynature **DOLPHIN REEF**. Help the students identify the different animals and objects that are found in a coral reef. Which of these animals might be food for a dolphin? Ask them if they have ever heard any of the animals make a sound. If so, can they imitate the sound with their voice?

STEP 3: Dolphins eat mainly small fish and sometimes squid, crabs, shrimp or other small marine animals. Dolphins and toothed whales use something called echolocation to help them hunt for food. They listen for echoes from the sea floor in order to orient themselves and avoid swimming into large objects. The echoes that bounce off objects tells them the size, shape, speed, distance and direction of the object. The amount of time it takes for the sound echo to come back to their ears helps them to identify how far away things are. The longer it takes for the sound waves to return, the more distance between them and the object or prey. Explain to the class that they will be playing a game to help them experience what it is like for dolphins to find food in their ocean environment.

STEP 4: Divide the class into groups of 10 students. If space is not available for all groups to play the game simultaneously, then groups may take turns playing. This is best played outside or in a large room.

SETTING UP THE GAME: Cut out the cards from *Activity Sheet 5: Echolocation Game* and place them in a container. There should be one card for each player, and only one dolphin

Disneynature DOLPHIN REEF

Lesson 6

Sounds of the Sea

card. Each player draws a random card from the container to determine their role in the game.

Help the students practice the sounds needed to play the game. To locate food, the child with the dolphin card claps hands twice to represent the echolocation sound. To indicate their location, students who have animal prey cards pat their chests twice with their open hands. To indicate their location, students who have object cards pat their thighs twice with their open hands. Make sure all players know how to produce and recognize each sound.

The dolphin walks to the center of the coral reef space and is gently blindfolded without covering the ears.

Once the dolphin is blindfolded, everyone else moves quietly to stand somewhere within the space, but not too close to each other.

PLAY THE GAME:
The game begins when the dolphin makes the echolocation sound (two hand claps).

Everyone replies to the dolphin sound by making their location sound at the same time.

The dolphin may take three steps slowly toward the location where a prey animal may be standing. The dolphin repeats the echolocation sound and the prey and obstacles repeat their location sounds.

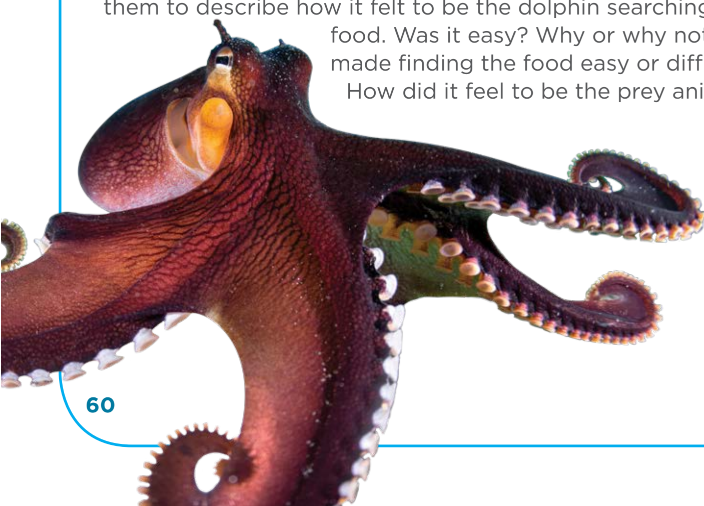
When the dolphin believes a prey animal is close, they reach out a hand and try to touch the person that is making the prey location sound.

The dolphin chooses another player to become the next dolphin and trades roles with that person. Continue playing until everyone has had a chance to be the dolphin.

VARIATION:
Allow players who are prey animals to move one step after each dolphin echolocation sound to try to escape from the dolphin.

Wrap Up

After the students have had a chance to play the game, ask them to describe how it felt to be the dolphin searching for food. Was it easy? Why or why not? What made finding the food easy or difficult? How did it feel to be the prey animal?



Whale Songs — A Mindful Activity

Extension: Art and ELA (Grades 2–6)

Enrich students' insights into the unique characteristics of animals from Disneynature with extension activities from different content areas.

Warm Up

When sounds are organized in some way, they become music. There are many ways to organize sounds, such as repeating patterns of pitches (melody), making patterns of long and short sounds (rhythm), making a slow or fast beat for the sounds to follow (tempo), or using different instruments and voices to organize the sounds.

STEP 1: Explain to students that when whales are alone in the ocean, sometimes they make sounds that seem like a song. Although scientists are not exactly sure why whales sing, they think it might be related to mating rituals, since only males sing. The sounds they make can range from very low sounds that sound like moans, to very high sounds that are like whistles. The low sounds can travel very far in the ocean. Some have been heard more than 1,000 miles (1609 km) away.

STEP 2: Slowly read the following script to guide students in mindful listening. (Repeat breathing instructions or augment the script to last about 3 minutes):

We are going to listen to a whale song in a special, quiet way. Sit in a comfortable position. When you are comfortable, close your eyes softly. Begin to calm yourself by just noticing your breathing. Let your breathing relax you. Breathe in.... and out. In..... out.....

Continue to breathe slowly and peacefully as you relax your body.

(Begin the audio playback from https://soundcloud.com/iwhales/gabriel)

The sounds you are hearing are a whale song.

(pause)

Let the sound come to you and fill your ears.

(pause)

Just listen and breathe. Breathe in.... and out.

(pause)

Notice if you make any judgments about the sounds and let the judgments pass away.

(pause)

Lesson 6

Sounds of the Sea

Notice if you are trying to put a name to the sounds. Instead, just focus on hearing the sounds by themselves.

(pause)

Continue to breathe in…. and out.

(pause)

Listen as the sounds rise and fade away. Notice if there are any spaces between the sounds.

(pause)

When your mind wanders away, gently return your attention to the flow of the whale song as it is happening right now.

(pause)

Just listen and breathe.

(pause)

When you are finished listening, bring your attention back to your breathing, and slowly open your eyes. Notice your surroundings as your body and mind return to their usual level of alertness and wakefulness.

(Fade the volume of the song until there is silence)

(pause)

Keep with you the feeling of calm as you return to your normal day.

Wrap Up

Ask the students what their experience was like. Encourage them to stop and breathe and listen to the world around them when they are facing a difficult challenge or not having the best day.

WEB RESOURCES

https://www.ted.com/talks/peter_tyack_the_intriguing_sound_of_marine_mammals

http://www.whalefacts.org/what-is-a-whale-song/

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Disneynature DOLPHIN REEF

ACTIVITY SHEET 1

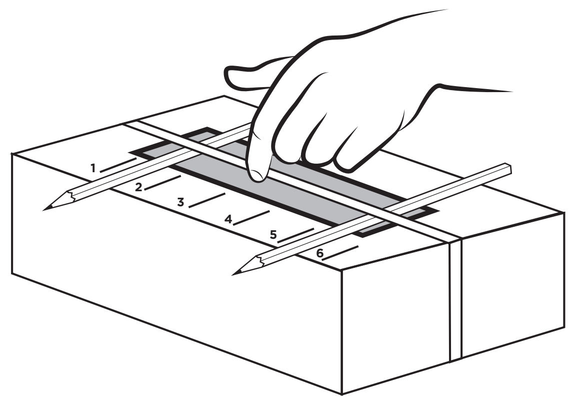
Sound is Vibration

Disneynature DOLPHIN REEF

Name ______________________ Date ______________________

Explore Sound Vibrations:

1. Pluck the rubber band by using your finger to move the rubber band sideways and then let it slip from your finger.
   - Listen to the sound the band makes while watching the movement of the band. What happens? Can you see the band move? How long does it move? What happens to the sound if you pluck harder or softer?
   - Record your observations in the table below.



2. Next, move one of the pencils to a mark on the box that is closer to the other pencil, and pluck again between the two pencils. Now what happens? Is the sound different? How? Record your observations in the table.
3. Continue to discover differences in the sound as the pencil is moved to different locations under the band, and as you pluck harder or softer on the band. Record your observations in the table.

Pencil 1 Location	Pencil 2 Location	Pluck (hard, medium, soft)	Sound range (high, medium, low)	Vibration time (short, medium, long)
1	6	medium		

Discuss your findings at the table with others.

- Was the vibration time longer or shorter with hard plucks? Why?

____

____

- Was the sound range higher or lower with pencils closer together? Why?

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____

ACTIVITY SHEET 2

Sound Waves Move

Name ______________________ Date ______________________

Explore Wave Movement

Sound waves are different than waves in water. You can see what sound waves look like by using a Slinky.

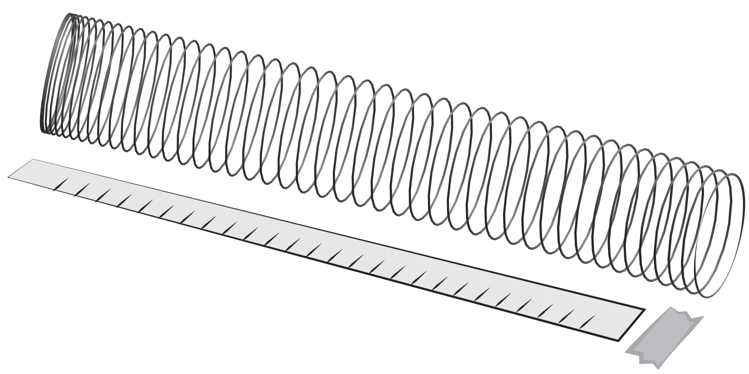
1. Sit on a floor that is smooth (like wood or concrete, not carpeted) or sit across from someone at a long table that is smooth.
2. Lay a Slinky on its side, and let a partner grab one end and stretch the Slinky until it is almost completely stretched out (about 6 to 8 feet between you to your partner). Put a piece of tape on the floor (or the table) where your end of the Slinky begins, and another piece of tape on the floor at your partner's end of the Slinky.
3. Now quickly push your end of the Slinky a few inches toward your partner, then quickly move your hand back to where it started at the tape mark. Your partner should not move their end of the Slinky. Watch what happens. Does it look like part of the Slinky moved from you to your partner?

What's Happening?

The **energy** of your push creates a wave that moves down the Slinky. This is how sound waves would look if we could see them.

Go Further!

1. Lay a yardstick beside your end of the Slinky with one end of the stick lined up with the tape on the floor and the other end of the stick pointing toward your partner. You can now measure how far you push the Slinky.
2. Push the Slinky using different lengths for your push. What happens to the wave? Record your observations in the table below.



Push Length	Observations

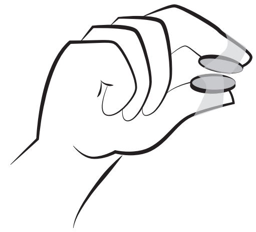
6

ACTIVITY SHEET 3

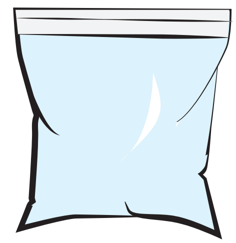
Sound Moves Through Different Materials

Name ______________________ Date ______________________

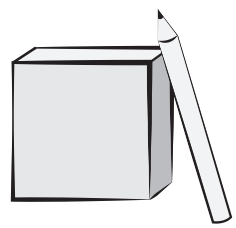
Explore Waves in Different Materials



1. Tape a coin to your thumb and another coin to your pointer finger using a small amount of tape. You should be able to hear a click sound when you tap your thumb and pointer finger together quickly. Hold the fingers that have coins taped to them about 4 inches from your ear. Make a clicking sound with the coins. Try to remember the sound. How loud is it? How high or low is it? Record your observations in the table.



2. Next, use your other hand to press the bag filled with water against your ear while you click the coins next to the bag. Do you hear the clicking sound? Is it different from the sound made without the bag covering your ear? How? Record your observations in the table below.



3. Finally, hold the block of wood in front of you and tap it with a plastic pen. Try to describe the sound and remember it. Now hold the wood block against your ear and tap the outside of the block with the pen. Do you still hear a sound? How is it different from the sound of the block when it was not against your ear?

Sound Observations

Mark an “X” in the loudness column to indicate which of the two sounds is louder.

Write down a description of how the highness or lowness of the second sound compares to the first sound. Also describe any other changes you notice in addition to loudness and highness/lowness.

	Loudness	Change in Sound
Coins in air		
Coins through water		
Wood in air		
Wood directly on ear		

ACTIVITY SHEET 4

Sounds Can Bounce

Disneynature DOLPHIN REEF

Name ______________________ Date ______________________

1. Close your eyes and listen carefully as you make a loud "Shhhhhh" sound that continues for at least 5 seconds. How would you describe the sound? Record your observations of what the sound is like in the table below.
2. Now hold the tray at arm's length away from your face. Close your eyes and make the "Shhhhhh" sound again. Aim the sound at the middle of the tray. While the sound continues, slowly move the tray closer to your face and then away again. How does the sound change as you move the tray? Try it several times. Can you hear differences? Record your observations of how the sound changes in the table below.
3. Cover the tray with rubber and repeat the sound and movement. What happens to the sound when compared to the uncovered tray?
4. Cover the tray with cloth and repeat the sound and movement. What happens to the sound when compared to the uncovered tray or the rubber-covered tray?

		Description Of Sound (loudness, high or low, direction, etc.)
Without Tray	Without tray	
Uncovered Tray	Far Away	
	Close	
	Moving Closer	
	Moving Away	
Tray With Rubber	Far Away	
	Close	
	Moving Closer	
	Moving Away	
Tray With Cloth	Far Away	
	Close	
	Moving Closer	
	Moving Away	

Sound bounces (reflects) off materials in different ways. We can hear differences in the sounds as they bounce. Which material allowed the sound to reflect the most (had the biggest differences in sound as the tray moved)?

Circle your answer: **Uncovered tray** **Tray with rubber** **Tray with cloth**

Think about the differences between the uncovered tray, the tray with a rubber cover, and the tray with a cloth cover. List reasons why you think sound reflects differently from these materials:

____

____

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ACTIVITY SHEET 5

Echolocation Game

Disneynature DOLPHIN REEF

WHAT AM I?

Dolphin

PREDATOR:
Clap hands twice

WHAT AM I?

Mackerel

PREY:
Pat chest twice with open hands

WHAT AM I?

Shrimp

PREY:
Pat chest twice with open hands

WHAT AM I?

Cuttlefish

PREY:
Pat chest twice with open hands

WHAT AM I?

Octopus

PREY:
Pat chest twice with open hands

WHAT AM I?

Coral

OBSTACLE:
Pat thighs twice with open hands

WHAT AM I?

Coral

OBSTACLE:
Pat thighs twice with open hands

WHAT AM I?

Crab

PREY:
Pat chest twice with open hands

WHAT AM I?

Sea Turtle

OBSTACLE:
Pat thighs twice with open hands

WHAT AM I?

Rock

OBSTACLE:
Pat thighs twice with open hands

Predator:
Clap your hands twice

Prey:
Pat your chest twice with open hands.

Obstacle:
Pat your thighs twice with open hands.

Term Glossary

Abstract: Expressing a quality or characteristic apart from any specific object or instance.

Adaptation: A trait that helps an animal or plant survive in its environment.

Algae: A plant or plantlike organism, mainly aquatic, that lacks true roots, stems and leaves.

Analogy: A comparison between two unlike things based on a similarity of a particular aspect.

Animation: The art and science of making pictures, or images, appear to move.

Biomimicry: The imitation of natural biological designs or processes used in engineering or inventions.

Bioengineering: The application of biological techniques to create modified versions of organisms.

Cladogram: A branching diagram that explains to biologists the relationship between different species.

Designer: Someone that creates a new work of art.

Echolocation: The process by which animals, such as dolphins, locate objects by emitting sounds and hearing the echoes as the sound bounces back.

Elusive: Hard to comprehend or define.

Endangered Species Act: Legislation that provides a program for the conservation of threatened and endangered plants and animals and the habitats where they can be found.

Energy: The power to make things move, make machines work, and make living things grow.

Engineer: A person trained and skilled in the design, construction and use of engines or machines.

Emulate: To try to equal.

Flip book: A small book filled with a series of images in different positions that create an animation when the pages are turned quickly.

Foraging: To go in search for food.

Frequency: A way to describe how fast or slow an object is vibrating.

Function: To work in a particular way.

Loudness: A measure of volume.

Opportunistic: Feeding on whatever food is available.

Organism: An individual animal, plant or single-celled life form.

Pitch: The highness or lowness of a sound.

Predator: An organism (usually an animal) that eats other animals for food.

Prey: An animal that is food for another animal.

Prototype: An original model of an invention.

Scale: The ratio of the dimensions of the representation to the same dimensions of the real object.

Species: A group of very similar organisms.

Symbiotic relationship: A relationship between two organisms that may or may not benefit one or both.

Tempo: Making a slow or fast beat for the sounds to follow.

Transitional: In the process of changing from one position or stage to another.

Vibration: The movement of sound going back and forth.

Waves: The pattern of disturbance caused by the movement of energy traveling through a medium, such as water.

Sources:
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