GEORGIA AQUARIUM

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Cold Water Quest: Classify and Collaborate

Student Activity

Biologists develop systems and categories to classify and organize all living things on the planet. In the 18th century, a Swedish botanist named Carl von Linné divided everything into two kingdoms: plants and animals. He based these classifications on whether or not the organisms could move around or make their own food (photosynthesis). Since then, thanks to advances in technology, we have discovered many more living creatures. Today, there are six recognized kingdoms of life.

Cold Water Quest at Georgia Aquarium is home to many members of the animal kingdom. Species in this gallery showcase amazing adaptations to harsh environments. From the coasts of South Africa and Japan, all the way north to the Arctic Ocean, **Cold Water Quest** provides a glimpse at life in some of the world's cooler ecosystems. Four of the animals in **Cold Water Quest** are featured in this activity: African penguin, beluga whale, giant Pacific octopus and southern sea otter.

After you compare and contrast these four marine animals in Part 1, you will undertake a design challenge based on several factors that make these animals more alike than different. Because the penguin, whale, octopus and otter are highly intelligent, they require enrichment activities when they are in human care. You will be charged with designing and building a new enrichment activity—or "toy"—for one of these four animals based on the requirements and guidelines provided in Part 2. Your **Cold Water Quest** design challenge has a twist! Since the natural environments of these animals are threatened by manmade trash, your enrichment item must be made out materials that are repurposed, recycled or reused.

***Terms to Know**: ballast, breeding, cephalopod, cetacean, dorsal, enrichment, invertebrate, non-biodegradable, phyla, propel, prototype, repertoire, taxonomist, vertebrate*

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African Penguin

While penguins might look clumsy and awkward on land, they are perfectly engineered for an aquatic life. Unlike the hollow bones in birds that can fly, the penguins' bones are solid to provide ballast when diving. The shape of their wings helps propel them through the water up to 12.5 mph for short bursts. Even their vision, which is nearsighted on land, is excellent underwater.

The African penguin is an endangered species. It is threatened by natural predators, loss of natural habitats and food supplies, and oil spills. As its name suggests, this penguin is found in Africa. Specifically, it lives on the coast and on 24 islands at the southern tip of South Africa and Namibia. African penguin populations have dropped 60% in the last 30 years. Georgia Aquarium helps these animals through breeding programs and partners with a conservation organization in South Africa.

Beluga Whale

When you hear a beluga whale for the first time, you will understand why this animal is nicknamed the "sea canary." Belugas have the most diverse vocal repertoire of all cetaceans. Their sounds include whistles, clicks, chirps, groans, trills, buzzes, roars and pulses. This "language" is one of the many characteristics that demonstrate the high intelligence and social nature of these animals.

Belugas have unique physical adaptations that allow them to survive and thrive in the Arctic Circle. Pale grey to white skin (10 times thicker than the skin of a dolphin!) camouflages perfectly with ice and snow. To conserve body heat, belugas have a dorsal ridge instead of a dorsal fin. Their flippers and flukes are also smaller than those of other whales because less surface area means less body heat can escape.

Giant Pacific Octopus

The most intelligent invertebrate on Earth lives in the Pacific Ocean, from tidal shallow pools to caves almost a mile beneath the surface and everywhere in between. The giant Pacific octopus is the largest species of octopus in the world. No bigger than a grain of rice at birth, it can grow to 16 feet from the top of its head to the tips of its eight arms. Each arm has two rows of suckers, with as many as 250 suckers on each one.

As a member of the Mollusca phylum, the octopus is related to snails and clams. Its class, cephalopod, means "head-foot" because its eight "feet" are attached to its "head," which holds a beak, a large brain and three hearts that pump blue blood. Usually reddish-brown in color, the octopus is a master at camouflage, just like other cephalopods. It can change both the texture and the color of its skin in an instant.

Southern Sea Otter

Sea otters are found in coastal areas along the northern Pacific Ocean. The southern sea otter is a subspecies that lives along the coast of central California. They rarely venture onto land, preferring environments with rocky or muddy sea bottoms. Sea otters can even sleep in the sea by wrapping up in strands of kelp to keep from floating away!

Sea otters are marine mammals, but as members of the family Mustelidae, they are closely related to weasels and wolverines. Because sea otters do not have blubber, they have the densest fur of any animal on earth to stay warm. They also eat 20% to 25% of their body weight each day to maintain their temperature. The feeding behaviors of sea otters showcase their intelligence and curiosity. They even use rocks as tools to get to their preferred snacks!

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Part 1

The animal kingdom is separated into two groups or subkingdoms: vertebrates, those that have backbones, and invertebrates, those that don't. Vertebrates are further divided into birds, reptiles, mammals, amphibians and fish. The diverse collection of life at Georgia Aquarium includes representatives from several invertebrate phyla and all five vertebrate phyla.

The chart below shows the classifications for four species in **Cold Water Quest**. You may recognize some Latin and Greek root terms in this classification system. (A bonus lesson in word origins!)

Read the descriptions of the animals on the previous page and the information in the chart below to answer ten questions about how these four animals are classified and named.

	African Penguin	**Beluga Whale**	**Southern Sea Otter**	**Giant Pacific Octopus**
Kingdom	Animalia	Animalia	Animalia	Animalia
Group or Subkingdom	Vertebrate			Invertebrate
Phylum	Chordata	Chordata	Chordata	Mollusca
Class	Aves	Mammalia	Mammalia	Cephalopoda
Order	Sphenisciformes	Cetartiodactyla	Carnivora	Octopoda
Family	Spheniscidae	Monodontidae	Mustelidae	Octopodidae
Genus	*Spheniscus*	*Delphinapterus*	*Enhydra*	*Enteroctopus*
Species	*Spheniscus demersus*	*Delphinapterus leucas*	*Enhydra lutris nereis*	*Enteroctopus dofleini*

1. (a.) Which of these four animals does not have a backbone? (b.) What is its phylum?

_____

_____

2. What is the name of the phylum for the three vertebrates?

_____

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3. One synonym for bird is “avian.” Look at the classification for the penguin. What do you think is the origin of the word “avian”?

4. (a.) How many feet, or “pods,” does an animal in the order Octopoda have?
(b.) Name a geometric term that also uses the “octo” prefix.
(c.) What do you think “octogenarian” means?

5. All four of these animals are carnivores, but only one is in the order Carnivore. Which one?

6. Which two of the four animals are most closely related? How do you know?

7. How does the species’ genus feature in its scientific name?

8. The word for the African penguin’s genus, *Spheniscus*, comes from Latin, and originally ancient Greek. It means “wedge-shaped.” Why do you think the penguin was given this name?

9. The scientific name for the beluga whale is *Delphinapterus leucas.* It translates from Greek as white (*leucas*) dolphin (*delphis*) without a wing (*apterus*). Why is this an appropriate description for the beluga?

10. One of these animals was named in honor of German zoologist Franz Doflein (1873-1924). Which animal is it?

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Part 2

These four species may look very different, but their intelligence and their environments make them more alike than it appears. What do they have in common?

They…

- live in salt water that is less than 60^{O}F.
- have diets that include fish and invertebrates like clams, crabs, mussels, squid and shrimp.
- are highly intelligent animals.
- are threatened by ocean pollution in their natural environments.
- receive enrichment items specially selected for their species when they are in human care.

These commonalties also form the basis of your design challenge! Your class will be divided into groups. Each group will choose or be assigned one of these four animals: African penguin, beluga whale, giant Pacific octopus or southern sea otter.

The first step in the Engineering Design Process is to define your problem. In this case, you need to create an animal enrichment activity out of repurposed or recycled materials. Use the Guiding Questions and the Design Plan Worksheet on the following pages to research, plan and build your activity or toy. At the conclusion, submit your worksheet to your teacher and present your enrichment item to the class. Maybe you will see your plan in action in one of the **Cold Water Quest** habitats on your next trip to Georgia Aquarium!

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Guiding Questions

1. What is the purpose of your enrichment object?

Enrichment activities and objects at aquariums and zoos are created for three main reasons. Which category will your group choose?

- First, they are used to teach an animal a certain movement that makes it easy to do medical care. For example, animals can be taught to roll over and show their bellies during an exam.
- Another reason for enrichment is to practice behaviors that an animal needs to survive in their natural habitat. These behaviors include hunting for dinner.
- The third reason is because animals should be mentally and physically stimulated so that they're healthy and thriving.

2. Is it appropriate for your animal?

Think about the things your animal does naturally and how it uses its senses. Research the species to learn about what they are good at and what they prefer to do.

- Do they usually have to work for their food, like an otter smashing open a clam? Otters prefer breaking apart "popsicles" with a snack frozen inside.
- Do they use multiple senses at once, like an octopus who tastes and touches with its suckers? A hamster ball with a treat inside can occupy an octopus as it figures out how to open the ball.
- Do they prefer to collect things, like a penguin gathering sticks and branches for its nest? Natural materials like small branches can be reused as nest-building materials for penguins.
- Is sound and communication part of their daily life, as it is for belugas?

3. Is it safe?

Enrichment is supposed to be stimulating, not dangerous!

- If it incorporates food items, are they safe for the animal?
- Can the animal use it without help from people?
- Is it safe for other animals in the same habitat?
- Are there any sharp edges? If it falls apart, will sharp edges be revealed?
- Could the animal throw it out of the habitat?
- Are there holes where body parts could get stuck?
- Are there pieces the animal could choke on?
- Are the materials waterproof and non-toxic?

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Design Plan: Cold Water Quest Animal Enrichment

Team Members: _____
_____
_____

Animal Species: _____

Name of Product: _____

Research: Take a look at other enrichment ideas for your species that are currently being used in zoos and aquariums, including Georgia Aquarium. Select three that your team found inspiring. Record the website and describe the idea.

Website	**Idea**
1.	
2.	
3.	

Brainstorm: Describe one idea for this project that your team rejected and the reason(s) why. Then explain how the idea your group selected addresses the Guiding Questions. Use separate pages if necessary.

1. One idea we rejected, and the reason for rejecting it, is: _____
_____
_____
_____
_____
_____
_____

2. The idea we agreed upon is: _____

3. The enrichment purpose of our idea is: _____

4. It is appropriate for our animal because: _____

5. It is safe for our animal because: _____

Plan: Non-biodegradable plastics are found in every ocean of the world. Instead of adding to the trash that threatens whole ecosystems, find a new use for it. List your materials here and include a sketch of your plan on separate paper.

Materials:

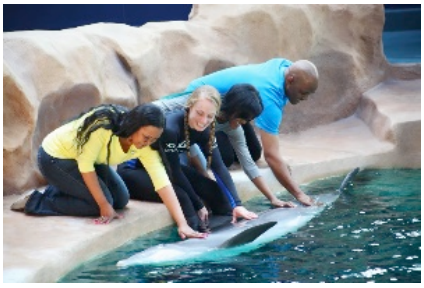
Build: As you build your prototype, you will encounter unexpected problems. Describe one such complication and how your group adapted.

Demonstrate

1. Test your enrichment item in water before you present it to your class.
2. During your group's demonstration, describe how it was made and how it is meant to be used by the animal. Ask your classmates for ideas on how to further develop your design.

Evaluate: In the Engineering Design Process, the final step always leads back to the first step. Based on your experience as a team and the feedback you received from your class, think about how you might improve your eco-friendly enrichment activity. (a.) What changes would your team make to a second version of the prototype? (b.) Which step of the design process was most difficult for your team and why?

The penguins go for a "Waddle Walk" around the Aquarium as part of their enrichment program.
http://news.georgiaaquarium.org/multimedia/album?id=573f553d2cfac25bf63cf97a&t=photo&p=16&s=order



This dolphin presents its belly during an Animal Encounter program at the Aquarium. Behaviors like these are important because they allow medical staff to examine an animal and provide care when needed.
http://news.georgiaaquarium.org/multimedia/album?id=53f4adaf7241c80db8006fb6&t=photo&p=16&s=order