Nature's Innovations

Video Titles: *Sponges: Filter Feeding Made Visible; Sponge Animation: Wild Ride Through a Sponge; Cnidarians: Deep Sea Research; Flatworms: The First Hunter; Annelids: Abarenicola, Burrowing Worm; Arthropods: Blue Crab Molting; Molluscs: Nautilus Regulates its Buoyancy; Echinoderm: Sea Star Time Lapse, Eating Mussel.*

Activity Subject: Biomimicry

Grade Level: 7 – 12 grades

Introduction

Antoni Gaudi, the famous Spanish architect, found his inspirations from nature. From trees to light to whale bones, Gaudi used solutions from nature for structural support or decoration. He is not unique in using natural engineering to solve problems in our daily lives. In this lesson, we will investigate how, through the process of evolution, animals have solved their engineering problems and how people have mimicked those natural solutions.

Note: Find pictures of Gaudi's La Sagrada Familia for inspiring Art Nouveau examples of inspirations from nature. (suggested site: http://en.wikipedia.org/wiki/File:Sagrada_Familia_nave_roof_detail.jpg)

Assessments

Worksheet

Time

1 to 1.5 class periods (depending on the length of discussions)

Group Size

3 or 4 students

NEXT GENERATION SCIENCE STANDARDS

PERFORMANCE EXPECTATIONS:

Students who demonstrate understanding can:

MMS-ETS1-1 - Engineering Design. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

HS-ETS1-2 - Engineering Design. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Learning Objectives:

Through observing video, discussion, and critical thinking students describe the animal solutions to engineering problems and think of a comparable human problem and a solution that is inspired by the animal's solution.

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Materials, Preparation and Procedure

Pair this activity with viewing of short videos that are easily accessed from the home page of the Shape of Life, shapeoflife.org.

Following is the list in order of use of seven video clips used in this lesson:

Sponge – (in Behavior), Sponges: Filter Feeding Made Visible (2:17 minutes) and (in Animations), Sponge: Wild Ride Through a Sponge (2:19 minutes)

Cnidarians – (in Other Topics), Cnidarians: Deep Sea Research (8:39 minutes or go from minute 2:00 to 3:10)

Platyhelminthes – (in Phyla), Flatworms: The First Hunter (9:54 minutes)

Annelids – (in Behavior), Annelids: Abarenicola, Burrowing Worm (2:38 minutes)

Arthropods – (in Behavior), Arthropods: Blue Crab Molting (2:24 minutes)

Mollusks – (in Behavior), Molluscs: Nautilus Regulates its Buoyancy (1:54 minutes)

Echinoderms – (in Behavior), Echinoderm: Sea Star Time Lapse: Eating Mussel (2:47 minutes)

Materials and Preparation:

- Activity worksheet for each student or for groups of students

Procedure:

1. Challenge the class to think of ways humans have borrowed ideas from nature to solve our problems.
2. Point out the accomplishments of Antoni Gaudi and display pictures of the interior of "La Sagrada Familia" showing how Gaudi borrowed ideas from the strength of branching trees to design the ceiling and support system for this gigantic cathedral.
3. Show the two video clips on Sponges as referenced above. As a class, discover the animal's solution to its problem. The class records and sketches this solution on their worksheets.
4. Form the class into "engineering committees," then in these committees have the students read about the human problem that is similar to the sponge's problem. Using the solution inspired from the sponge, the students think of how humans have solved this problem. Students should briefly describe and sketch the solution on the worksheet.
5. Continue working in this pattern for the next 6 videos to apply the invertebrate solution to shed light on the human problem.
6. In conclusion, invite one student engineer from each group to an inner circle group. Have them discuss their group's ideas, reflecting on lessons learned from nature.
7. Finally, students turn in one worksheet per engineering group.

Note: If possible, student groups may access the videos independently on their own computers and work at their own pace. This would allow multiple viewings of clips and individualized pacing.

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Teacher Edition Worksheet

(Note: The human solution is just a suggestion. Students might have other valid ideas.)

Think of how people have used ideas from animals to solve engineering problems.

Animal	Animal Problem	Solution	Sketch	Human problem	Solution	Sketch
Porifera (Sponges)	How to move food to many cells without a mouth	Pump and filter system		How to clean a swimming pool	Pump and filter system similar to sponge's system	
Cnidarians (Jellyfish)	How to catch swimming or drifting food in the water	Tentacles, stinging cells (nematocysts), bioluminescence (though the video doesn't mention this)		How to catch fish in the water	Longline fishing gear with baited hooks and lights	
Platyhelminthes (Flatworm)	How to move with intent to hunt	Developed a bilateral body with a head, eyes and a brain		How to drive a car more safely	Sensing system to avoid crashes, computer in engine, back-up camera	
Annelids (Burrowing Worm)	How to get underground	Segmented body, coordinating muscles, powerful proboscis		How to drill for sediment cores or oil	Long, thin hollow drill with powerful drill bit and pumping fluid	
Arthropods (Crabs)	How to protect soft body parts yet still be able to move	Exoskeleton, jointed appendages		How to protect soldiers in battle	Suit of armor with chain mail or modern Kevlar	
Molluscs (Nautilus)	How to swim when you have a heavy shell	Shells have chambers with removable water that make buoyancy possible		How to float under the water while SCUBA diving	Buoyancy compensator allows the diver to add or subtract air into a vest to be neutrally buoyant	
Echinoderms (Sea Stars)	How to eat an animal with a protective shell	Strong water vascular system in tube feet, for prying, stomach comes out of body and digests soft body parts of prey		How to extract gold from ore	Use of poisonous cyanide to dissolve the hard ore and get the gold (process banned in many countries.)	

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View the video clips for each animal listed on the table below (see video reference to find how to access the videos on shapeoflife.org). As a group, describe the animal's solution to its problem and sketch the solution. Read the comparable human problem and write & sketch a solution that is inspired by the animal's solution.

Think of how people have used ideas from animals to solve engineering problems.

Animal	Animal Problem	Solution	Sketch	Human Problem	Solution	Sketch
Porifera (Sponges)	How to move food to many cells without a mouth			How to clean a swimming pool		
Cnidarians (Jellyfish)	How to catch swimming or drifting food in the water			How to catch fish in the water		
Platyhelmin-thes (Flatworm)	How to move with intent to hunt			How to drive a car more safely		
Annelids (Burrowing Worm)	How to get under-ground			How to drill for sediment cores or oil		

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View the video clips for each animal listed on the table below (see video reference to find how to access the videos on shapeoflife.org). As a group, describe the animal's solution to its problem and sketch the solution. Read the comparable human problem and write & sketch a solution that is inspired by the animal's solution.

Think of how people have used ideas from animals to solve engineering problems.

Animal	Animal Problem	Solution	Sketch	Human Problem	Solution	Sketch
Arthropods (Crabs)	How to protect soft body parts yet still be able to move			How to protect soldiers in battle		
Molluscs (Nautilus)	How to swim when you have a heavy shell			How to float under the water while SCUBA diving		
Echinoderms (Sea Stars)	How to eat an animal with a protective shell			How to extract gold from ore		

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Student Video Reference

Sponge – Under Topics, click on Behavior, click on Sponges: Filter Feeding Made Visible (2:17 minutes).

And Under Topics, click on Animations, click on Sponge: Wild Ride through a Sponge (2:19 minutes)

Cnidarians – Under Topics, click on Other Topics, click on Cnidarians: Deep Sea Research (8:39 minutes total or go from minute 2:00 to 3:10)

Platyhelminthes – Under Topics, click on Phyla, click on Flatworms: The First Hunter (9:54 minutes)

Annelids – Under Topics, click on Behavior, click on Annelids: Abarenicola, Burrowing Worm (2:38 minutes)

Arthropods – Under Topics, click on Behavior, click on Arthropods: Blue Crab Molting (2:24 minutes)

Mollusks – Under Topics, click on Behavior, click on Molluscs: Nautilus Regulates its Buoyancy (1:54 minutes)

Echinoderms – Under Topics, click on Behavior, click on Echinoderm: Sea Star Time Lapse: Eating Mussel (2:47 minutes)