

# **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.



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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 with- out 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 (nemato- cysts), biolu- minescence (though the video doesn't mention this)		How to catch fish in the water	Longline fish- ing gear with baited hooks and lights	
Platyhelmin- thes (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 under- ground	Segmented body, coordi- nating mus- cles, powerful proboscis		How to drill for sediment cores or oil	Long, thin hol- low drill with powerful drill bit and pump- ing fluid	
Arthropods (Crabs)	How to protect soft body parts yet still be able to move	Exoskeleton, jointed ap- pendages		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 remov- able 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 ani- mal with a protec- tive shell	Strong water vascular sys- tem in tube feet, for pry- ing, stomach comes out of body and digests soft body parts of prey		How to extract gold from ore	Use of poison- ous cyanide to dissolve the hard ore and get the gold (process banned in many coun- tries.)	

the Shape of Life

# Nature's Innovations | Student Edition Worksheet - Page 1

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

	Sketch				
	Solution				
problems.	Human Problem	How to clean a swimming pool	How to catch fish in the water	How to drive a car more safely	How to drill for sediment cores or oil
animals to solve engineering problems.	Sketch				
Think of how people have used ideas from animals	Solution				
/ people ha	Animal Problem	How to move food to many cells without a mouth	How to catch swimming or drifting food in the water	How to move with intent to hunt	How to get under- ground
Think of how	Animal	Porifera (Sponges)	Cnidarians (Jellyfish)	Platyhelmin- thes (Flatworm)	Annelids (Burrowing Worm)



# Nature's Innovations | Student Edition Worksheet - Page 2

shapeoflife.org). As a group, describe the animal's solution to its problem and sketch the solution. Read the comparable human View the video clips for each animal listed on the table below (see video reference to find how to access the videos on 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.	Solution         Solution         Solution         Sketch           Problem         Problem         Sketch         Sketch	How to pro- tect soldiers in battle	How to float under the water while SCUBA diving	t How to extract gold from ore
we used ideas from an				
k of how people ha	Animal Animal Problem	Arthropods How to (Crabs) protect soft body parts yet still be able to move	Molluscs How to swim when you have a heavy shell	Echinoderms How to eat (Sea Stars) an animal with a protective shell



# Nature's Innovations

**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)