

Plant and Animal Structure Lesson 3: *The Engineer* Educator's Lesson Plan

Objective

In *The Engineer*, students will:

1. Study a variety of plant and animal structures and their functions.
2. Choose an animal or plant species of interest to inspire the planning and development of a product that uses the principles of biomimicry to solve a human problem.

Time Required: 200 minutes

Materials Required	Safety/Other Considerations	Science & Engineering Practices
<ul style="list-style-type: none"> • Plant and Animal Resource Cards • Paper • Colored pencils/markers • Product construction materials: possible construction materials could include but are not limited to: various types of paper, cardboard, tape, glue, pipe cleaners, popsicle sticks, elastic bands, and straws 	None	<ul style="list-style-type: none"> • Designing solutions • Communicating findings/design (oral presentation)

Inquiry Scale: Leveling Information

Level 1: most teacher-driven (*recommended for grades 4-5*)

Choose four species of interest (from Appendix B) to use for this class activity. *Please note: although twelve resource cards exist for this activity, in order to provide more assistance to students, only four cards (of choice) should be used.* As a class-wide activity, review each chosen plant or animal species with students in order to discuss the species and its unique structures that help it to survive.

Next, ask all students to brainstorm a list of human problems that could be solved by using a product that mimics the plant or animal structure. To assist students' thinking, discuss with students biomimicry examples provided in Appendix A in order to demonstrate how a plant or animal structure inspired a human product. Create a class-wide brainstorm list of problems for each of the four species cards chosen for this activity.

After the class-wide list of problems has been generated for each species, assign each student team one of the four species cards. The student team must choose one of the brainstormed problems from the class list and must plan and design a device to solve this human problem using the principles of biomimicry. Lead student teams through the Student Guide Planning Organizer for their assigned plant animal species. Assist student teams in the planning and execution of the remainder of the Student Guide Planning Organizer sections associated with this *Engineering* challenge.

Level 2 (recommended for grades 5-6)

Choose six species of interest (from Appendix B) to use for this class activity. *Please note: although twelve resource cards exist for this activity, in order to provide more assistance to students, only six cards (of choice) should be used.* As a class-wide activity, review each chosen plant or animal species with students in order to discuss the species and its unique structures that help it to survive.

Next, choose one of the six species to use for modeling the planning of this *Engineering* activity. Present your chosen species to the class and ask all students to brainstorm a list of human problems that could be solved by using a product that mimics the plant or animal structure. To assist students' thinking, discuss with students biomimicry examples provided in Appendix A in order to demonstrate how a plant or animal structure inspired a human product. Create a class-wide brainstorm list of problems for the model species cards chosen for this activity.

After the class-wide list of problems has been generated for each species, inform students that they are going to repeat this process for their newly assigned species. Assign each student team one of the chosen six species cards (including the species that was just modeled). Lead student teams through the Student Guide Planning Organizer for their assigned plant or animal species. Assist student teams in the planning and execution of the remainder of the Student Guide Planning Organizer documents associated with this Engineering challenge.

Level 3: (recommended for grades 6-7)

Choose one species of interest (from Appendix B) to model for this class activity. As a class-wide activity, review the chosen plant or animal species with students in order to discuss the species and its unique structures that help it to survive. Next, ask all students to brainstorm a list of human problems that could be solved by using a product that mimics the plant or animal structure. To assist students' thinking, discuss with students biomimicry examples provided in Appendix A in order to demonstrate how a plant or animal structure inspired a human product. Create a class-wide brainstorm list of problems for the model species in order to walk students through an example biomimicry planning process for a species of interest.

After the class-wide list of problems has been generated and discussed for the model species, assign each student team one of the eleven remaining species cards. Lead learners through the first parts of the Student Guide Planning Organizer and consult with student groups to assist in brainstorming ideas unique to their selected species. Learners decide individually what solution they will engineer and complete the remainder of the engineering activity independently.

Level 4: most student-driven (recommended for grades 7-8)

Learners independently choose a species of interest for this *Engineering* activity. Learners complete all aspects of *The Engineer* process, and design their own solutions for a biomimicry product. Use class sessions to consult with student groups and "coach" students through this design challenge.

Agenda

I. Show PowerPoint to introduce the Engineer Activity (20 minutes)

The PowerPoint will review essential concepts learned in *The Make* and provide context for students' upcoming *Engineer* challenge.

II. Engineer Activity (150 minutes)

To prepare: Print and cut the appropriate number of cards from "Appendix B: Plant and Animal Resource Cards." (See the Inquiry Scale for card recommendations). Provide 1 set of cards per table group.

Tip: Laminate the cards before cutting so that you can reuse them each year. If color printing is not possible, project the cards from Appendix B.

As guided by the organizer, students will:

1. Review a variety of plant and animal resource cards in order to learn about unique structures used for species survival.
2. Choose a plant or animal of interest.
3. Brainstorm a list of human problems that could be solved with a device that mimics the structure of a chosen plant or animal.
4. Choose a key human problem to design a product for based on the concepts of biomimicry.
5. Plan and create a technical drawing of the design solution.
6. Build the final product and design a presentation poster to explain the product.
7. Present biomimicry products to the class audience.

If students need suggestions or ideas on places to get started on their Engineering challenge, give them suggestions from the "Engineering Suggestions to Spark Student Ideas" document in the Appendix, below the Assessment Rubric.

III. Presentation and Assessment (30 minutes)

Presentation/Assessment

Students present their final design solutions as if they are presenting to an audience of business investors working alongside the Biomimicry Institute, interested in patenting and marketing their design; assessment parameters are suggested below.

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Engineer Assessment: Project Grade and Rubric Score Sheet - Plant and Animal Structures

Project Submitted by _____

Your Challenge: Use biomimicry to design a device that solves a human problem of interest.

Project Completion:

- Completion of all aspects of Engineering Planning Guide including:
 - Plant/Animal Research
 - Engineering Device Planning Template
- Presentation Poster Requirements:
 - Clear and creative title
 - Includes a drawing of the organism from which the focus structure originated
 - Labels the organism AND
 - Labels the structures
 - Includes a caption that explains the function of the plant or animal structure chosen and how it helps the organism survive
 - Includes a technical diagram of the biomimicry product/device design
 - Labels are included to explain parts of the product/device and how it works
 - Includes a caption to explain how the product/device mimics a plant or animal structure
 - Includes a caption to explain how the product benefits the human client
 - Diagrams and captions are arranged in a logical order
 - Presentation poster is neat and in color
- Device is built according to prototype design plans, using appropriate materials

DCI Standards Checklist:

- Accurate research of plant/animal structure of interest
- Biomimicry Device:
 - Device clearly and accurately “mimics” the properties of the plant or animal structure chosen
 - Device functions to solve the human problem of interest
 - Design solution is realistic, relevant and could accurately be used to solve a human problem

Science & Engineering Practices Rubric



	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Designing Solutions	Applies no scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies minimal scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies adequate scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies complete scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.
Communicating Findings/Design (Oral Presentation)	Findings/design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/design are completely communicated with some misconceptions. Or uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings/design are completely communicated but lacking depth and complexity. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.

Teacher Comments:	
Final Score:	Final Grade:

Appendix A: Engineering Suggestions to Spark Student Ideas

Example Biomimicry Products

*Ideas provided for learner inspiration to improve upon and create scenarios to apply existing solutions

<p>DfcXi Vh`JYWc`</p> 	<p><u>=bgd]f]b['D`Ubh'cf '5b]a U`GdYVWYg`</u> 6i fXcW`6i ff`</p> <p><u>Ghfi Vfi fY`cZ`=bhYfYgh`</u> < cc_gcb Vi fXcW`Vi ffg`hUh`Y`d Vi ffg` UhtUW`hc`Uj Uf]Ym'cZ'g' fZUW'g`"</p> <p>J Y`Wc`k Ug`XYj Y`cdYX`]b`%` (%VmGk`]gg` Yb[]bYf; Ycf[Y`XY`A` YghfU`"5Zhf`fYa`cj`]b[` Vi ffg`Z'ca` \]gXc[`UbX`gh`Xm]b[`h`Y`ghfi`Vfi`fY` cZ`h`Y`Vi`ff`i`bXYf`U`a`]W'cgV'edY'Z`A` YghfU` X]gV'ej`YfYX`h`Y`ga`U` \`cc_g`Uh`h`Y`YbX`cZ`h`Y` Vi`ff`b`YX`Y`"H` \]gX]gV'ej`YfmgdUf`_YX`h`Y` VWYU]cb`cZ`J`Y`W'cZ`U`d'fc`Xi`Vfi`VUgYX`cb`h`Y` ghfi`Vfi`fY`cZ`h`Y`Vi`fXcW`Vi`ff`"</p>
<p>DfcXi Vh`GA`]b` UbgYb`6`i` ``YhHfU]b`</p> 	<p><u>=bgd]f]b['D`Ubh'cf '5b]a U`GdYVWYg`</u> ?]b[Z]g`Yf`'6]fX`</p> <p><u>Ghfi Vfi fY`cZ`=bhYfYgh`</u> ?]b[Z]g`Yf`V]fX`VYU`_`</p> <p>8i`Y`hc`h`Y`ghfi`Vfi`fY`UbX`g`UdY`cZ`]hg`VYU`_zh`Y` _]b[Z]g`Yf`V]fX` \Ug`h`Y`UV`]`]mhc`X]j`Y`]brc` k`UhYf`dYfZV`Vfi`mk`]h`'a`]b]a`U`]a`dUW'Z`U`ck`]b[` k`UhYf`hc`YUg]`ma`cj`Y`cj`Yf`]hg`VYU`_`k`]h`ci`h` VWYU]b[`U`f]dd`Y`]b`h`Y`k`UhYf`"9`]`B`U`_Uhg]`Z` Ub`Yb[]bYf`UbX`V]fX!`k`UHW`Yfz`hcc`_`]bgd]fU]cb`Z'ca`h`Y`_]b[Z]g`Yfz`UbX` fY!`XYg] [bYX`h`Y`bcgY`cZ`h`Y`fU]b`"H`Y`bcgY`cZ` h`]g`f`U]b`U`ck`g`h`Y`f`U]b`hc`a`cj`Y`Uh`ZUg`Yf` gdYX`g`Ug`]hg`]Wg`h`fci` [\`h`Y`U]f`k` \]Y` fYXi`Wb[`bc]gY`"</p>

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DfcXi Wh`G\Uf`g`]b`Gk]a gi`]tg`



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h`Y`XYg][`b`cZXYfa U`XYbh]WYg`UbX`\`Uj`Y`
Udd`]YX`h`]g`XYg][`b`hc`gk`]a`gi`]hg`hc`\`Y`d`
gk`]a`a`Yfg`a`cj`Y`a`cfY`YZZ]WYbhmi`h`fci`[\`
k`UHyf`"5XX]h]cbU`nž`h`Y`XYg][`b`cZXYfa U`
XYbh]WYg`\`Ug`VYyb`Udd`]YX`hc`U`h`]b`Z]a`i`gYX`
hc`Vč`U`h`h`Y`Vč`h`ca`c`ZVcUhg]b`cfXYf`hc`U`ck`
VcUhg`hc`a`cj`Y`a`cfY`YZZ]WYbhmi`h`fci`[\`k`UHyf`"

Appendix B: Plant and Animal Resource Cards

12 Examples

Octopus



- Arms have suction cups on the bottom to touch and taste
- They have no bones, so they can fit through small spaces
- Camouflage to blend in with their surroundings

Thorny Devil



- Skin can absorb water that the scales then send to its mouth for a drink

Red Maple Tree and Maple Fruit



- Lightweight wings allow the seed to float away from the tree

African Elephant



- Trunk is used for smelling, breathing, drinking, trumpeting, and grabbing things
- Tusks are used to dig for food

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Fennec Fox



- Large ears to cool off during the day and to listen for insects to eat
- Thick fur keeps them warm during the cool nights

Snowshoe Hare



- Large furry feet help them move across the snow
- White fur in the winter and brown in the summer help them blend in with their surroundings

Beaver



- Waterproof fur and webbed feet for swimming
- Long flat tail helps them swim faster, gives them balance, and also makes a loud alarm sound when slapped against the water

Osprey



- Long legs, large feet, and hooked talons for fishing
- Waterproof feathers
- Sharp hooked bill for eating fish

