LONGWOOD GARDENS

Natural Engineering Program

Pre- and Post-Activities

BACKGROUND FOR TEACHER

Students will have an opportunity to explore nature's genius while visiting Longwood Gardens. Students will see plants that are native to different biomes, including the desert, the tropical rainforest, and the Mediterranean. During the program, students will mimic unique plant characteristics to engineer an original design. Students will study and copy a structure and/or function that exists in the natural world.

Biomimicry is a new science that uses nature as inspiration to solve current human problems. The science of biomimicry is changing the way humans go about solving problems. Humans are studying and learning from nature, not just learning about nature. Scientists are learning *how* and *why* nature does things, then applying what they learn to solve human problems or improving the way humans do things.

Some examples of biomimicry include buildings created in the shape of termite mounds, airplanes shaped like birds, honeycomb workspaces, Velcro, Japan's bullet train, waterproof paint and clothing, as well as swimsuits for Olympic swimmers. Scientists continue to make new discoveries that result in unique applications.

The *process* of looking at nature differently is the goal of Longwood's Natural Engineering Program.

VOCABULARY

Adaptations
Bio-engineering
Biomimicry
Eco-engineering
Function
Hydrophobic
Structure

NEXT GENERATION SCIENCE STANDARDS

Life Science: From Molecules to Organisms: Structures and Processes

K-LS1-1	Use observations to describe patterns of what plants and fruit need to survive.
1-LS1-1	Use materials to design a solution to a human problem by mimicking how plants and/or fruit use their external parts to help them survive, grow, and meet their needs.
4-LS1-1	Construct an argument that plants and fruit have internal and external structures that function to support survival, growth, behavior, and reproduction.

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Engineering Design

K-2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

PRE- AND POST-ACTIVITIES

Waterproof Experiment (K-2)
Curriculum Connections: Science
Materials: 1 head of cabbage, 1 stalk of fresh broccoli, spray bottles, water, paper, coloring tools (markers, crayons, colored pencils), paper towels

1. Gather the students around a table to view the experiment.
2. Hold up the broccoli as the first example. Ask students what will happen when the vegetable is sprayed with water.
3. Spray the broccoli with water, and discuss observations as the water beads and rolls off.
4. Give each student one cabbage leaf and have them return to their desks.
5. Discuss the characteristics of the cabbage leaf. Is it soft? What color is it? Is it smooth?
6. Walk around the room and spray each cabbage leaf with water. Encourage students to share observations.
7. Hand out paper towels to dry the desks.
8. Hand out the paper and coloring tools.
9. Ask the students to think about the experiment, and the water resistant quality observed. Can this characteristic be applied to something else? Think of things you use every day. Can you name something that you would like to make water resistant?
10. Have students create an image of a waterproof design.
11. Share designs and display.

Extension/Modification Activity: Continue the experiment with other fruits or vegetables to compare hydrophobic qualities. Adapt lesson for older students by adding a research component on hydrophobic qualities.

Traveling Seeds (3-8)
Curriculum Connections: Science, engineering
Materials: Various seeds, cups, water, book *The Dandelion Seed* by Joseph Anthony

1. Read *The Dandelion Seed* by Joseph Anthony.
2. Discuss how the dandelion seed traveled in the story. What about the seed allowed it to fly?
3. Give each student two different seeds and a cup of water.
4. Students will place one the seeds in the cup of water. Does the seed sink or float? Would either seed be able to travel by water? Why or why not?
5. Students will toss each seed in the air, and watch to see where the seed lands. Would either seed be able to travel by air like the dandelion seed? Why or why not?
6. Compare results. Compare the shape, size, and weight of each seed.

Extension/Modification Activity: Students may collect seeds of fruit eaten at home and do the same comparison. Students can create structures to help a seed travel by water or air using arts and craft materials available.

Shapes in Nature (3-8)
Curriculum Connections: Science, engineering, visual arts
Materials: Various art supplies: 81/2 x 11 pieces of foam board or cardboard, markers, paint, clear tape, glue, construction paper, a sample of honeycomb (jars of honey with honeycomb can be found in any natural food store or grocery store), white paper, pencils, magnifying glasses (optional)

1. Pass around the sample of honeycomb for students to see up close. Ask students to describe what they see.
2. Give each student a piece of paper and a pencil. Have students draw the shape of the honeycomb. Be sure to note how many sides each section of the comb has.
3. Next, challenge students to think of a way that the honeycomb shape can be used in another way. Students may use this time to brainstorm ideas. (Ideas might include using the shape for desktops, office spaces, puzzles, toys, playground equipment, candy shapes, shelving, etc.)
4. Using the art supplies, allow students to create something new in the shape of the honeycomb.
5. Students might be encouraged to work in teams for this project.
6. Students can present finished models to the class.

Extension/Modification Activity: Take students outdoors to find something in nature that has an interesting shape. After sketching that shape in nature, have students apply the shape to something new. Students could use a magnifying glass to seek out small shapes in nature.

Packaging Challenge (3-8)
Curriculum Connections: Science, engineering
Materials: Fresh sugar snap peas or string beans, cardstock paper, scissors, glue**,** any kind of hard cookies (vanilla wafers work great)

1. Give students one sugar snap pea or string bean to dissect. Have students examine how the small beans are nestled inside the outer layer.
2. Discuss the fact that these beans inside the pod are actually the seeds for a new plant and the pod is the protective layer.
3. Give students a small, hard cookie.
4. Challenge the students to create a package for the cookie to keep it from breaking or cracking.
5. Allow students to use pieces of cardstock to construct a cookie package. (be sure to give each student the same amount of materials)
6. Experiment with each package created. How sturdy is it? Will it break if you placed it in your backpack?
7. Compare results and packaging. Which shapes worked best?

Extension/Modification Activity: Have students create packaging for other fragile items. Add other materials such as cotton balls, fabric, or string to create packaging.

WEB RESOURCES FOR TEACHERS

Biomimicry Institute
www.biomimicry.org

Engineering, Go For It! Dream Up the Future
http://teachers.egfi-k12.org/

Ask Nature
www.asknature.org

Teach Engineering – Curriculum for K-12 Teachers
www.teachengineering.org

Arbor day Foundation
www.arborday.org

SUGGESTED PRINT RESOURCES FOR TEACHERS

Baumeister, Dayna Ph.D. *Biomimicry Resource Handbook*. First Public Printing, 2014. Print.

Benyus, Janine M. *Biomimicry: Innovation Inspired by Nature*. New York: Morrow, 1997. Print.

Cornell, Joseph Bharat. *Sharing Nature: Nature Awareness Activities for All Ages*. Crystal Clarity Publishers, 2015. Print.

SUGGESTED PRINT RESOURCES FOR STUDENTS

Gates, Phil. *Nature Got There First*. Kingfisher, 2010. Print.

Goodman, Susan E., and Dorothy Handelman. *Nature Did It First!* Brookfield, CT: Millbrook, 2003. Print.

Lee, Dora, and Margot Thompson. *Biomimicry Inventions Inspired by Nature*. Kids Can Press, 2011. Print.

Morgan, Emily. *Next Time You See a Maple Seed*. Arlington, VA: National Science Teachers Association, 2014. Print.

Anthony, Joseph. *The Dandelion Seed*. Nevada City, CA: Dawn Publications, 1997. Print.