

SIEMENS STEM DAY ACTIVITY

BIOMES AND BIOMIMICRY

OBJECTIVES

Students will be able to:

- **Analyze** how effective design enables plants and animals to survive in harsh climates
- **Apply** that knowledge to a product in order to **create** an original design, and
- **Evaluate** computer aided designs presented by their peers.

STEM LESSON FOCUS

Engineering Design Cycle

- Designing Solutions

21st Century Skills

- Collaboration

LEVEL OF DIFFICULTY

2

GRADE RANGE

9–12

ACTIVITY TIME

45–60 min

BUSINESS CATEGORY

IT

TOPIC

Mimicking Nature

OVERVIEW

Climate change is one of the biggest problems facing our modern society. The effects of climate change include rising tides, arid land, and harsh weather patterns. Engineers, scientists, and designers can look to nature's own engineering brilliance to find time-tested solutions to emerging environmental crises. This approach, known as biomimicry, offers a useful framework for addressing the problems of the future. In this activity, students will work in teams and use the approach of biomimicry to build an Adaptation Station that will enhance life for humans living in a specific environment. Students will brainstorm and generate virtual models of their products using any free Computer Aided Design software.

MATERIALS

For this lesson, teachers will need:

- A projector or screen
- A smartphone or tablet with a camera and access to the internet (one per student)

For this lesson, teachers will need:

- **Adaptation Station Student Worksheet**

- A computer with access to the internet and the CAD software of your choice installed

Note: *Prior to engaging in this classroom activity, it is recommended that educators familiarize themselves and their students with CAD software.*

*Free CAD software is available for educators and high school students from several online resources including:

[Siemens PLM Solid Edge](#)

[Google SketchUp](#)

[Tinkercad](#)

[Blender](#)

HAVE YOU EVER WONDERED...

How polar bears survive in arctic climates? From the very beginning of life on earth, the process of natural selection benefitted organisms that adapted favorably to their environment. It is this process of natural selection that allows a species to adapt and evolve to a climate, even if that climate might be inhospitable. In the case of the polar bear, they share a genome with brown bears and grizzly bears, but special adaptations allowed them to survive in temperatures far colder than their cousins. Over time, polar bears split off from other bear species and developed circulatory systems that could process large amounts of fat. This allowed the bears to eat blubber-rich foods like seals, which are commonly found in the arctic. The fat from the seals is then stored in the polar bear's body, accounting for up to 50% of the bear's total weight. The polar bear's extra layer of body fat enables it to thrive in the frigid temperatures of the arctic.¹

How we can learn from the plants and animals around us in order to solve the pressing challenges facing society? Biomimicry is the name given to the process of applying design principles from nature to the products, policies and processes that humans create. Scientific principles such as competitive exclusion and natural selection have refined species over millions of years. We can ascertain sound design principles by learning from what has (and hasn't) worked in nature.

¹ Pennisi, Elizabeth. "Polar Bear Evolution Was Fast and Furious." American Association for the Advancement of Science. May 8, 2014.

MAKE CONNECTIONS!

How does this connect to students?

Students use and see modeling software in video games, movies, and TV, but in this lesson, they will see how emerging technologies can also be used to effectively communicate complex concepts. The team-based approach of this activity encourages students to think creatively, constructively and thoroughly about the issue of climate change.

How does this connect to careers?

Climatologists research the weather patterns of the earth and apply that knowledge to help address climate issues.

Materials scientists use the properties of matter to improve the design of products in many realms, from the creation of non-stick cooking surfaces to the design of moisture-wicking clothing meant to maximize athletic performance.

Biotechnologists use the principles of biology to create and improve products. Biotechnologists work in many different fields, including genetic engineering and pharmaceutical production.

How does this connect to our world?

All of us are impacted by the health of our planet, and sometimes the most innovative solutions to pressing challenges come directly from the planet itself. This activity will encourage students to think critically about how sciences like biology and chemistry offer tools that we can use to address real-time global problems.

If you want students to further explore career opportunities connected to this topic, please allow for more classroom time.

BLUEPRINT FOR DISCOVERY

Follow the instructions below to complete the activity.

1. Divide the class into four groups. Provide each group with the following (2–3 minutes):
 - a. Computer or tablet that is sufficiently charged, connected to the internet, and has a CAD software application downloaded.
 - b. One copy of the **Adaptation Station Student Worksheet**.
2. Invite students to view an image of gecko climbing feet, a kingfisher, and of an armadillo shell. Ask students to brainstorm what types of inventions might have been inspired by these animals. The gecko climbing feet led to pads that can hold human weight, allowing humans to climb up vertical surfaces. The break design of the kingfisher inspired the bullet train. The armadillo inspired the design of a recycle rubber backpack, that is flexible, but durable. Explain to students that biomimicry uses nature as a model for human inventions. Many creative minds turn to nature to imitate designs and ideas.

3. Provide time for students to read through the **Adaptation Station Student Worksheet**. Ask students to use a close reading strategy to clarify the problem being presented. Students should:
- Use a check to note directions that they understand
 - Draw a star next to important points
 - Use a question mark for anything they are unsure about or have a question
 - Circle any text they might need more information about

Review any questions students have before they begin.

4. Allow students 30 minutes to brainstorm and design their Adaptation Station prototype using CAD software, providing assistance as needed. Available free CAD software provides a platform for students to draw in 3D. This will allow students the opportunity to design their innovation without having to use physical materials.
5. Invite each group to display their Adaptation Station design and rotate to other groups to see other design ideas. Student groups should use sticky notes to leave feedback on how effectively their designs would fit into the biome.

TAKE ACTION!

Inspired? Students and educators can use the following resources to learn more about climatology, biotechnology and augmented reality:

[Climate.gov—Science and Information for a Climate Smart Nation](#)

[The Biomimicry Institute](#)

[Aurasma—Augmented Reality Webcasts](#)

NATIONAL STANDARDS

International Society for Technology in Education

[International Society for
Technology in Education](#)

1. Creative Communicator
- b) Students create original works or responsibly repurpose or remix digital resources into new creations.

SIEMENS STEM DAY

[SiemensStemDay.com](#)

ADAPTATION STATION WORKSHEET

You and your classmates are attending a climate summit hosted by the world's leading climate scientists, engineers, and biotechnologists. The purpose of the summit is to design products and materials that will protect humans as Earth's climate becomes inhospitable. The professionals agree that biomimicry, the technique of mirroring nature's design when manufacturing new products and materials, is the design approach they would like to use. They share the philosophy that the plants and animals that have adapted to difficult climates have much to teach us about how humans can also survive in challenging terrain.

You and your classmates have been invited to the conference in order to take on a special mission—you will be split into four groups in order to design Adaptation Stations in different areas of the globe. These Adaptation Stations will offer resources to humans in four different climates:

Desert (dry, arid climate)

This climate is characterized by a lack of water and extremes in temperature. The day is searingly hot and the nights' dip down near freezing. The diminishing ozone makes the risk of sun exposure particularly dangerous to humans.

Arctic (frigid climate)

This climate faces a lack of available food resources due to the permafrost of the soil. Temperatures are most often below freezing and unpredictable weather makes transit difficult. Therefore, it is difficult to get adequate resources to those living in a frigid climate.

Sea (island climate)

Construction in a sea-based climate is difficult due to the changing nature of the ocean floor. Rising tides mean that flooding is to be expected. Because of limited land, it is difficult to produce a variety of foods.

Tropical (jungle climate)

The biodiversity of the jungle climate means that human inhabitants have access to ample food, but run the risk of interacting with many species that may be harmful or dangerous. The humid nature of these climates increases the risk of transmission of diseases like malaria.

Each group must design an Adaptation Station that has 3 products inspired by animals or plants that inhabit their assigned terrain. These products must help humans survive in this harsh climate. Groups must build a CAD model of their station using CAD software and present their model to the conference. The future is in your hands! Use the engineering design process to create an Adaptation Station we can all count on!