Dear Educators,

The Biomimicry Youth Design Challenge (YDC) is an authentic STEM learning experience that empowers learners to pursue project-based-learning skills needed to solve real-world problems. Working with an adult coach, learners explore biomimicry and apply their new understanding to create biomimicry solutions to global and local sustainability problems. For additional details, visit the Youth Challenge Home Page.

Designing a nature inspired solution to a sustainability problem requires students to connect:
- Biomimicry
- Sustainability Problem
- Designed Solutions

The YDC guides learners through the creation of a biomimetic design using the MIMIC Instructional Approach. Each 5E instructional segment is one in the five phased MIMIC series.

**MOTIVATE** Get inspired! Motivate your team by exploring biomimicry. Discover how the unique abilities of organisms help them to survive and thrive, and how people have been inspired by them to design solutions to challenging problems.

**INVESTIGATE** Investigate the causes and effects of a sustainability problem you would like to solve. Identify the impact your solution will need to have to address the problem effectively.

**MATCH** Explore how nature has solved problems similar to yours by matching what you need your design to do with organisms that have similar abilities. Examine the features of these organisms and why they have those abilities, and determine which organisms could inspire your solution.

**INNOVATE** Create a biomimicry innovation that would help solve your selected problem. Refine your innovation after evaluating its strengths and weaknesses.

**COMMUNICATE** Use evidence to explain how your biomimicry design solves the selected problem and how nature has inspired it.

Youth Education at the Biomimicry Institute
YOUTH DESIGN CHALLENGE STORYLINE

The Earth is facing a number of large, shared ecologic and economic problems. The UN has established 17 sustainability goals that will help the people of the planet move towards a better future. As we look for solutions to the problems we face, people can leverage the strength of nature’s designs. When we study and use nature as inspiration in our solutions, we are doing biomimicry. Using biomimicry to address human problems is not a new idea. Indigenous cultures and current businesses have used biomimicry to find creative ways to solve the problems they have been faced with. These problems might be world-scale issues or local issues. Some biological structures or behaviors can be more helpful than others when solving specific problems. To derive the best solution to a problem, the structures of many natural systems should be investigated and the most useful ones should be incorporated into the design of the solution. Solutions have strengths and weaknesses. It is important to test the solutions, and iterate them in order to increase the likelihood of their success. By implementing successful local solutions, we can contribute to the UN sustainability goals for the planet.

- **Anchor Phenomenon**: Nature solves its problems with well-adapted designs, life friendly chemistry and smart material and energy use.
- **Driving Question**: How can learning from nature help us solve local and global sustainability problems?

Science Standards

Forty-four states (representing 71% of U.S. students) have education standards influenced by the Framework for K-12 Science Education and/or the Next Generation Science Standards.

Foundational biomimicry, climate change, and design challenge alignments are shown in the table below. Alignment strength will depend on lesson choice, depth of instruction, and problem choice. Additional specific physical, earth, and life science standards can be selected by choosing a particular Sustainable Development Goal as the focus for the design challenge.
The foundational biomimicry, climate change, and design challenge alignments are shown in the table below. Alignment strength will depend on lesson choice, depth of instruction, and problem choice. Additional specific physical, earth, and life science standards can be selected by choosing a particular Sustainable Development Goal as the focus for the design challenge.

<table>
<thead>
<tr>
<th>DISCIPLINARY CORE IDEAS (DCI)</th>
<th>SCIENCE &amp; ENGINEERING PRACTICES (SEP)</th>
<th>CROSSCUTTING CONCEPTS (CCC)</th>
</tr>
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<tbody>
<tr>
<td><strong>BIOMIMICRY</strong></td>
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<tr>
<td>MS, HS - LS1.A: Structure and Function</td>
<td>• Developing and Using Models • Engaging in Argument from Evidence • Constructing Explanations and Designing Solutions</td>
<td>• Structure &amp; Function • Patterns • Systems &amp; System Models</td>
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<tr>
<td>MS, HS - LS4.C: Adaptation</td>
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| **ENGINEERING DESIGN**       |                                      |                            |
| MS, HS - ETS1.A: Defining and Delimiting Engineering Problems | • Asking Questions and Defining Problems • Developing and Using Models • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information | • Systems & System Models • Influence of Science, Engineering, & Technology on Society and the Natural World • Structure and Function |
| MS, HS - ETS1.B: Developing Possible Solutions |                                      |                            |
| MS, HS - ETS1.C: Optimizing the Design Solution |                                      |                            |

| **CLIMATE CHANGE**           |                                      |                            |
| MS, HS - ESS3.D: Global Climate Change | • Asking Questions and Defining Problems Analyzing and Interpreting Data • Developing and Using Models | • Cause & Effect • Stability & Change |
| MS, HS - ESS3.C: Human Impacts on Earth Systems |                                      |                            |

**ADDITIONAL PHYSICAL, EARTH, AND LIFE SCIENCE STANDARDS**

Choose a Sustainable Development Goal that matches your class or program content as the focus for the design challenge. Refer to the document, UN Sustainable Development Goals Aligned to NGSS, for suggested alignments.
The Motivate section of The Biomimicry Institute’s Youth Design Challenge (YDC) begins with students identifying a worldwide challenge that they would like to explore. Students connect the worldwide problem to one that may also exist in their local community. Students are then introduced to biomimicry as a sustainable design practice with the potential to help solve many of the challenges facing our world today. The final phases of the learning progression opens students’ eyes to the amazing biological strategies that all organisms possess that we can learn from as we design our world.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Question Aligned to the Storyline</th>
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</thead>
<tbody>
<tr>
<td>Introduction to biomimicry and identifying the problem.</td>
<td>How could practicing biomimicry help us design solutions to worldwide challenges?</td>
</tr>
</tbody>
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**ENGAGE**

Engage Questions:
- What are some current problems we are facing as a people?
- What problems in our local area align with the UN’s Sustainable Development Goals?

**PROCEDURE: PART 1**

What are some current problems we are facing as a people?

1. Tell students to think about issues that we see on the news and hear are being discussed all over the world. Give students about 2 minutes to think of an issue or problem that they would like to share. List the issues that students share and set aside for later in Motivate. **Optional extension:** Have students take the list generated and sort according to categories or themes they decide upon and explain their choices.

2. Tell students that the issues that they feel are important are recognized in some shape or form as challenges we need to face globally.

3. Watch the call to action video: *We The People for The Global Goals*. Afterwards have students read the *SDG Fact Sheet* looking for connections to the issues they have raised as important to us as a people.

4. Have students select a SDG that they feel passionate about for additional research. Ask students to be prepared to share answers to the following questions once they have selected a SDG.
   - Why have you chosen this SDG for further study?
   - What do you know about issues that are part of the SDG?
   - How might these issues be impacting your community?

5. Tell students that the Biomimicry Institute holds an annual creative challenge or contest called the YDC (Youth Design Challenge) that encourages students to apply solutions found in nature to human innovations, to help reach and achieve the SDGs. Give students the *YDC Design Brief* to read and discuss in small groups. A design brief is a document used by professional designers and their clients to communicate the context, goals, and requirements of a creative project.
**PROCEDURE: PART 2**

What problems in our local area are related to our selected Sustainable Development Goal (SDG)?

1. Show students the video of the SDG Summit in 2019 to understand the effort/urgency around realizing the goals. 2019 SDG Summit / Let’s Make it Happen

2. Do an exercise with students so that they are able to take the local problems they listed and align them to the SDGs.
   - Example: If you wrote down that temperatures are climbing every year and we have droughts and fires, then the SDG 13 is the one most connected. Show students the SDG 13 Sheet and scroll down to the Overview which has visuals of some of the problems listed below the goal on the top.

3. Have students revisit their chosen SDG for the purpose of aligning their problems to the correct goal and doing research around the factors contributing to the problems listed.

4. Ask students to log onto pre-approved sites to research local problems. The students should confirm that the SDG that they've chosen has accessible information. Other forms of research might include: physically exploring your community, talking with family members, community members, or problem stakeholders.

**Additional Teacher Resource: Background on the UN SDG**

**EXPLORE**

Explore Questions:
- What is biomimicry and how can it give us ideas to solve problems?
- Who are nature’s design champions outside our door?

**PROCEDURE: PART 1**

1. Tell students that they are going to hear about a practice called biomimicry. Explain the bio = life and mimicry = imitate or copy. Show the founder of Biomimicry, Janine Benyus in The Promise of Biomimicry (22:36), then have students write down one thing they “Notice” and one thing they “Wonder” about biomimicry based on the video.

2. After the video, have students share their “Notice and Wonder” to the whole group. Create a list to keep for discussion later in the instructional segment. Consider asking a student to record responses while they engage in the activity.

3. Tell students that biomimicry has been happening all around us. Show Biomimicry Examples Slides #1-4 one image at a time. Ask students each time: “How would you describe this example of biomimicry?”. Tell students that each image shows a pair of photos showing a bio-inspired technology and the organism that inspired it (model). Read (or request a student volunteer) the notes on the Biomimicry Case Studies after each image has been shown and students have an opportunity to discuss the images.

4. Give students the Biomimicry Definition and Key Terms Sheet. Have students put a tally mark next to the words used during discussions so that they can begin to build familiarity with the biomimicry words.

**PROCEDURE: PART 2**

Who are nature’s design champions outside our door? (OUTDOOR OPTION)

1. Have students watch the video “What is Biomimicry?” (2:03) before heading outdoors.

2. Give students a Nature Observation Sheet (Seeing Function) that they will use to keep track of what they “Notice and Wonder” while outside. Ask students if they have any questions about how to use the sheet prior to going outside.
3. Take students outside to complete the Nature Observation Sheet through the lens of biomimicry for about 15 minutes. After students make their observations, have them share what they found and add this to the chart you created earlier.

4. Explain to students that biomimicry goes beyond observing nature: that we also learn from nature. Show the image Two Viewpoints of a Tree and explain that knowing about something might require instant recall but learning from it is a more complicated task, requiring deeper learning, and that is our goal in biomimicry.

5. Pick either the first place winner for your grade band or a project of general interest to the class (Project videos are included in the Design Challenge (YDC) Winners Gallery). Tell the students that young people across the world have been (re)designing objects, processes and systems using biomimicry. Place students in small groups to view the previous Youth Design Challenge (YDC) Winners you have selected. Ask the students to think about the organisms the winners learned from (not about) as they created projects.

EXPLAIN (Vocabulary)

<table>
<thead>
<tr>
<th>Biological models</th>
<th>Biomimicry</th>
<th>Function</th>
<th>Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological strategy</td>
<td>Brief</td>
<td>Organism</td>
<td>United Nations</td>
</tr>
<tr>
<td>Biology</td>
<td>Design</td>
<td>Scientific Observations</td>
<td></td>
</tr>
<tr>
<td>Biomimic</td>
<td>Designer</td>
<td>Sustainability</td>
<td></td>
</tr>
</tbody>
</table>

Explain Question:
• What are the essential components of biomimicry?
• How do biomimicry designers talk about biomimicry and biological models?

PROCEDURE: PART 1

What are the essential components of biomimicry?

1. Ask students to think about the benefit of having three of something. Ask them how a stool with two legs would perform. Tell students that there is a rule of three: Latin phrase, “omne trium perfectum” (everything that comes in threes is perfect, or, every set of three is complete).

2. Tell students that there are three parts to an atom: protons, neutrons, and electrons. Three primary hues in the white light: red, green, and blue. Three major components of the earth: core (outer and inner), mantle, and crust. Three main types of rocks: igneous, metamorphic, and sedimentary. To have something in threes can demonstrate wholeness. Tell students that biomimicry has three essential parts: Ethos, (Re)Connect, and Emulate.

• Ethos is the philosophy of understanding how life works and creating designs that continuously support and create conditions conducive to life.

• (Re)Connect acknowledges that we are nature, finds value in connecting to our place on Earth as part of life’s interconnected systems, and encourages us to observe/spend time in nature to understand how life works so that we may have a more consistent ethos to emulate biological strategies in our designs.

• The last essential component of our biomimicry braid is emulat/emulation. The scientific, research-based practice of learning from and then replicating nature’s forms, processes, and ecosystems to create increasingly regenerative designs.
3. Tell students to look for each of these three strands at they complete the YDC and work towards their design solution.

PROCEDURE: PART 2

How do biomimicry designers talk about biomimicry and biological models?
1. Explain that biomimicry designers blend terminology from both biology and design. Tell students that during the design of an object, process or system, a biomimicry designer might need to translate what an organism can do into what an engineer might understand.
2. Explain that an organism can become a model for a design when it has abilities (traits and biological strategies) that perform the same function that a design/solution needs to perform.
3. Have students do the The Language of Biomimicry activity. Students can do this activity on their own, in small groups or led by a teacher. Tell students that biomimicry innovations are based on biological strategies of organisms. Let them know that AskNature.org is a website that organizes biological strategies by function to help biomimicry designers find inspiration for new innovations. Give students the AskNature Scavenger Hunt as an asynchronous or independent activity if desired.

ELABORATE/EXTEND

Elaborate/Extend Question:
• How would a biomimicry designer view and describe nature outside our door? (OUTDOOR OPTION)

PROCEDURE:
1. Have students watch CBS Sunday Morning: The Fascinating World of Biomimicry (6:00) that introduces some biomimicry designers and how they are solving problems by learning from nature.
2. Outdoor Activity would be to take students outside for Exploring Function in Nature using the Function Junction Cards Activity. The Function Junction Activity Cards allows students to select a function and explore outside for an organism that performs that function. These activities have modifications that allow for them to be done indoors.
3. Another optional activity is to invite a local naturalist, zoo staff, plant nursery staff, etc. (anyone who works closely with organisms) to speak to your class about the biological strategies they’ve encountered.

EVALUATE

Evaluate Question:
• How are students like us practicing biomimicry to create nature-inspired solutions to sustainability problems?

PROCEDURE:
1. Revisit the Youth Design Challenge (YDC) Winners whole group with the Design Brief in hand. Ask students to pick two to review and share what they saw on the website that excited them.
2. Identify components and steps of the YDC after viewing and discussing a video of a student team’s winning design, found on the YDC website.
3. Brainstorm what you need to know and be able to do to be successful in this design project.
4. Have students begin a Biomimicry Notebook that has a template of the submission documents with a document organizer. Show each page of the document and briefly discuss.
5. Have each student either write a one to three paragraph summary of what biomimicry is or fill out a Frayer Model as an assessment.

6. Essay writing prompt: Write a short one-to-three paragraph essay explaining what biomimicry is and how others have used biomimicry to design solutions to world challenges.

### ADDITIONAL RESOURCES

- **30 Animals that Made us Smarter Podcasts** (15-20 minutes)
- **How Does the Star Nosed Mole Sense AN Video** (3 minutes)
- **BEETLES I Notice I Wonder Activity Guide**