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.

**M**OTIVATE 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.

**I**NVESTIGATE 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.

**M**ATCH 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.

**C**OMMUNICATE 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.

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**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 Innovate section of The Biomimicry Institutes’s Youth Design Challenge (YDC) begins with having students using their abstractions to create and construct a prototype design, and then refining that design through several emulation and evaluation phases to reach their final design.

During this iterative process, students will create a visual representation that communicates how their biomimicry design solution addresses the selected problem and assists in reaching the chosen SDG.

As the Innovate section wraps up, students evaluate the design’s ability to provide a solution to the local problem. This is an important step in the design process as students will need multiple opportunities to improve their designs.

Students should continue taking photos and documenting their design process to show the improvements and explain why those changes were made.

<table>
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<tr>
<th>Goal</th>
<th>Question Aligned to the Storyline</th>
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<td>Refine a solution to more effectively address an identified problem.</td>
<td>How can we, as biomimicry designers, apply our abstractions to create a design that addresses our identified problem?</td>
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**ENGAGE**

**Engage Questions:**
- How do we go from our abstractions to a sustainable design?

**PROCEDURE**

1. Remind students that they’ve now discovered and abstracted several design principles from nature. They will now begin to capture the essence of the various strategies and mechanisms, through the emulate phase, moving into evaluating whether or not the design fulfills the Design Brief.
2. Tell students that you’ll now continue on your work of creating biomimetic designs using the biomimicry design process with a focus on emulate and evaluate:
   1) define 2) biologize 3) discover 4) abstract 5) emulate 6) evaluate
3. **Emulate** - Tell students that during this phase of the design process, they will look for patterns and relationships among the strategies that were abstracted. The goal of emulation is to combine the various biological strategies/abstractions into a functioning design.
4. **Evaluate** - Tell students that during this phase of the biomimicry design spiral the goal is to assess how well the design concept meets the Design Brief, while adhering to the criteria and constraints of the challenge.
EXPLORE

Explore Questions:
- What might be some patterns or relationships that arise from the abstractions and how could they be used in our design?

PROCEDURE:
1. Tell students that they will look at the data/research they have collected on organism strategies for the purpose of identifying a pattern or relationship among the abstractions.
2. Ask students to compare their abstractions side-by-side, looking for central ideas or unifying concepts that will summarize the strategy and can be used for design. It may be helpful to have students work in pairs or small groups on each of their abstractions.
3. Once the patterns or relationships have been identified from the various statements, have students begin the process of creating models of how the design might be achieved.

EXPLAIN (Vocabulary)

Innovation Mechanism Strategy

Explain Question:
- How might my abstractions (conceptual models) be used to create an innovation?

PROCEDURE:
1. Share the following quote from Richard Feynman with students... “If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in.” Ask students to have a dialog on how the phrase “language she speaks in” might be connected to the biomimicry abstractions.
2. Remind students of the path that they’ve taken:
   a. Students were given a Design Brief that asked them to identify and solve a problem connected to a global and/or local issue.
   b. Students were introduced to biomimicry as a way to create sustainable designs.
   c. Students were shown how organisms have lessons to teach us on solving problems through their designs.
   d. Students were asked to match their design needs with several organisms’ strategies.
   e. Students are now asked to create their innovation based on their research.
3. Tell students that they will make models of their design ideas. The models might be drawings, diagrams, or physical replicas. The important point to remember is that the model is clearly understandable to others and communicates the key features and purposes of their design. Encourage students to think about and incorporate details into their designs. Here are some questions you might ask:
   - What are the dimensions? How much space does it need?
   - What is my design made of? Are the materials sustainable, or sustainably sourced?

Teacher Resource: National Science Teaching Association, Developing and Using Models
ELABORATE/EXTEND

Elaborate/Extend Question:
• How will we test and refine our biomimetic design to improve its effectiveness in solving the identified problem?

PROCEDURE:
1. Tell students that design requires multiple models to be made and tested before settling on a design solution.
2. Encourage students to create two- and three-dimensional models that highlight the abstracted biological strategy used as an innovation. Consider having students manipulate and use homemade sculpting clay as a way to increase their awareness of the design features. Free, online websites and resources like TinkerCAD or 3D Slack can be easy introductions to 3D modeling and design, as well.
3. Tell students that the model that is created based on their abstractions might require several versions (iterations) before it is complete. Use class time for students to continue working on their biomimetic designs for however long seems reasonable. Note: Ideally, students would iterate two-to-three times before arriving at their final submitted work—each time refining their design based on data/evidence and justifying their design decisions in the light of their identified problem.

EVALUATE

Evaluate Question:
• How will we ensure that our biomimetic design functions effectively and appropriately addresses the identified problem?

PROCEDURE:
1. Have students review the strategies and mechanisms that informed their final design. Students will need to have a clear understanding of those concepts before moving on to complete their project.
2. Assess and explain how your final design helps solve the problem. If the design did not clearly solve the problem, describe why and propose changes to the design to make the design a more effective solution to the problem. It is also important to remind students that the biological strategies/abstractions should not simply be “an attachment” to their design, but should be the main component. A good way to assess this is by asking, “If I take the biological strategy away, does the design still function?” The goal is that it would not function without the biological strategy.
3. In small groups, create a visual representation of how your biomimicry design solution for the local problem contributes to reaching your chosen SDG.

ADDITIONAL RESOURCES
• Next Generation Science Standard: Appendix G - Crosscutting Concepts
• Bozeman Science Patterns Video
• Rapid Prototyping
• Homemade Sculpting Clay