



BIOMIMICRY

YOUTH DESIGN CHALLENGE



CREATING LOCAL SOLUTIONS TO GLOBAL PROBLEMS

AN INSTRUCTIONAL STORYLINE FOR THE BIOMIMICRY YOUTH DESIGN CHALLENGE
SUITABLE FOR GRADES 6-8 AND 9-12



ANCHOR QUESTION:

How can learning from nature help us solve a local sustainability problem that is connected to global climate change?

The Biomimicry Youth Design Challenge (YDC) is an authentic STEM learning experience that empowers classroom and informal learners with project-based-learning skills to solve real-world problems. Working with an adult coach, teams explore biomimicry and apply their new understanding to create biomimicry solutions to sustainability problems that impact global climate change. For additional details, visit www.youthchallenge.biomimicry.org

This Instructional Storyline was developed in consultation with Laura Arndt, Global GreenSTEM (www.globalgreenstem.com).

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M MOTIVATE

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LESSONS

- 1 DRIVING QUESTION:** How are students like us designing biomimicry solutions to sustainability problems?
Learning Goal: Students will be able to describe what they would need to know and do in the Biomimicry Youth Design Challenge.
- 2 DRIVING QUESTION:** What is biomimicry and how can living things give us ideas to solve problems?
Learning Goal: Students will be able to describe biomimicry in the context of real-world examples.
- 3 DRIVING QUESTION:** Who are nature's design champions outside our door?
Learning Goal: Students will connect biomimicry concepts to their observations of organisms living around them.
- 4 DRIVING QUESTION:** What is the value of nature and any individual organism?
Learning Goal: Students will consider the intrinsic and utilitarian value of nature and defend their viewpoints.
- 5 DRIVING QUESTION:** How would a biomimicry designer view and describe nature outside our door?
Learning Goal: Students will go outside to a natural area and examine structures, behaviors, and processes of plants and animals through the lens of function.
- 6 DRIVING QUESTION:** How do biomimicry designers talk about biomimicry and biological models?
Learning Goal: Students will use biomimicry terminology and conceptual understanding to describe organisms (biological models) and biomimicry innovations.
- 7 DRIVING QUESTION:** What can we learn about biomimicry from the nature-inspired designs and practices of Indigenous Peoples both past and present?
Learning Goal: Students will clarify the connection between traditional nature-inspired innovation by Indigenous Peoples and contemporary biomimicry through examples and explanations.

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LESSONS

- 8 DRIVING QUESTION:** How could our biomimicry design help solve a problem related to climate change and the UN Sustainable Development Goals (SDGs)?
Learning Goal: Students will set the context for the YDC within climate change issues and the SDGs.
- 9 DRIVING QUESTION:** What is climate change and how is it affecting our Earth, environment, and people?
Learning Goal: Students will explain the basic science of climate change, including its causes and impacts on humans and the natural world.
- 10 DRIVING QUESTION:** What problems in our local area are related to our selected Sustainable Development Goal (SDG)?
Learning Goal: Students will identify and research multiple local problems related to the SDG.
- 11 DRIVING QUESTION:** How will we decide which specific problem will be the focus of our design challenge?
Learning Goal: Students will use a decision-making process to select a local problem for their design challenge after they analyze and compare several problems and identify variables affecting possible solutions.
- 12 DRIVING QUESTION:** What does our design need to be able to do to solve the specific problem, and what are the limitations to our design?
Learning Goal: Students will define the boundaries (framework) for their biomimicry design, using SMARTER design guidelines to set criteria and constraints.

M MATCH

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LESSONS

- 13 DRIVING QUESTION:** Which organisms have strategies for solving problems that are similar to the problem we want to solve?
Learning Goal: Students will research and gather examples of how nature has solved problems similar to theirs.
- 14 DRIVING QUESTION:** How will we select the biological strategies that will become our models for a biomimicry solution?
Learning Goal: Students will compare the biological strategies they found to decide which would be most effective to use as models for their biomimicry design.

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LESSONS

- 15 DRIVING QUESTION:** How can we apply what we know about our biological model to create our biomimicry design?
Learning Goal: Students will translate the working principles of their biological models into design strategies and apply them to create a biomimicry design.
- 16 DRIVING QUESTION:** How will we ensure our biomimicry design functions effectively to solve the problem we identified?
Learning Goal: Students will create a model of a biomimicry design that could solve their selected local problem.
- 17 DRIVING QUESTION:** How will we test and refine our biomimicry design to improve its chances of success in solving the identified problem?
Learning Goal: Students will test their design model and/or get expert or stakeholder feedback, and then use their findings to refine the design and improve its chances of success.
- 18 DRIVING QUESTION:** How could our biomimicry design contribute to the many projects across the world working to reach the global SDG?
Learning Goal: Students will clarify how their solution to the local problem contributes to global efforts to reach the SDG.
- 19 DRIVING QUESTION:** How does our biomimicry design contribute to global efforts to slow or adapt to climate change?
Learning Goal: Students will clarify how their design both helps solve the local problem and contributes to global efforts to slow or adapt to climate change.

C COMMUNICATE

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LESSONS

- 20 DRIVING QUESTION:** How has practicing biomimicry shaped how we think about nature, problem solving, engineering, and technology?
Learning Goal: Students will reflect on the design experience individually and as a team.
- 21 DRIVING QUESTION:** How can we share what we have learned and experienced so others recognize biomimicry as an innovative design process for creating solutions to sustainability problems?
Learning Goal: Students will present their biomimicry design to a local audience and highlight its potential local and global impacts.
- 22 DRIVING QUESTION:** How do we submit our design project to the Biomimicry Institute's Youth Design Challenge?
Learning Goal: Students will create a video pitch for their design concept and assemble an award application.

STORYLINE OVERVIEW

This project storyline is a suggested sequence of connected lessons that guides students through a learning journey that includes exploring the fascinating world of biomimicry, investigating a local sustainability problem they would like to solve, and using the engineering design process to model a nature-inspired solution to the problem. For this storyline, global climate change—the context of the Biomimicry Youth Design Challenge—is framed locally to make this complex issue relevant and personally purposeful. Students first connect climate change to a specific UN Sustainable Development Goal (SDG), and then investigate and identify a local problem that addresses that goal. In designing a solution to the problem, they are helping reach the SDGs, and thus helping address climate change. Resources and lessons about the science of climate change are offered in the storyline and on the YDC website for those who want to offer more in-depth study of this issue.

The storyline can be followed in its entirety, used partially to support one or more areas of the YDC, used as a template to create your own storyline, or used to identify the lesson resources that fit into your own instructional plan.

EACH LESSON IN THE STORYLINE INCLUDES THE FOLLOWING ELEMENTS:

- A **driving question** that provide the foundation for each lesson and requires investigation or problem-solving to answer. As each driving question is answered and understood, it naturally leads to the next driving question, and so on until students have answered the anchor question.
- A **learning goal** that states the reason for the lesson by explaining what the learners will be able to do after completing the lesson.
- A description of **"what learners do,"** which outlines a sequence of class activities for students to investigate and use to answer the driving question.
- A description of **"what learners figure out,"** which describes the concepts or processes learned from the activities.
- A collection of **lesson resources**, including suggested videos, interactive websites, lesson plans, background information, articles, and other supportive resources for the activities described in "what learners do." All resources are indexed on the YDC website. Log in and go to the Instructional Storyline page of the Educator Resources.

For more about storylines, visit Next Generation Storylines: www.nextgenstorylines.org

BIOMIMICRY

YOUTH DESIGN CHALLENGE

MIMIC INSTRUCTIONAL APPROACH FOR BIOMIMICRY DESIGN PROJECTS



M

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.



I

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.



M

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.



I

INNOVATE

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



C

COMMUNICATE

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

MIMIC INSTRUCTIONAL APPROACH

DESIGNING A NATURE-INSPIRED SOLUTION TO A SUSTAINABILITY PROBLEM requires students to connect three understandings:

1. Biomimicry

Biomimicry's focus on the functions and strategies of living things to inspire innovative designs.

2. Sustainability Problem

The causes and effects of a sustainability problem.

3. Create a Solution

The application of the engineering process to create a bio-inspired solution to the problem.

THIS STORYLINE IS BUILT ON THE MIMIC INSTRUCTIONAL APPROACH.

This framework guides educators through the creation of a biomimicry-specific STEM learning experience. Beginning with **MOTIVATE**, learners will first build a strong foundational understanding of biomimicry. Then they **INVESTIGATE** their community to identify a specific local problem connected to global sustainability issues and climate change.

The design process for creating a model of a bio-inspired solution to the problem takes place in **MATCH**, **INNOVATE**, and **COMMUNICATE**. The most unique step is **MATCH**, in which teams explore the traits and strategies of living things for design inspiration. The process of creating and refining the design occurs during **INNOVATE**, and teams reflect on and present their solutions in writing, imagery, and via a video pitch during **COMMUNICATE**. At the conclusion of this lesson sequence, students are prepared to submit their innovations to the Biomimicry Youth Design Challenge.



NEXT GENERATION SCIENCE STANDARDS

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.

DISCIPLINARY CORE IDEAS (DCI)

SCIENCE & ENGINEERING PRACTICES (SEP)

CROSCUTTING CONCEPTS (CCC)

BIOMIMICRY

MS, HS - LS1.A: Structure and Function
MS, HS - LS4.C: Adaptation

- Developing and Using Models
- Engaging in Argument from Evidence
- Constructing Explanations and Designing Solutions

- Structure & Function
- Patterns
- Systems & System Models

CLIMATE CHANGE

MS, HS - ESS3.D: Global Climate Change
MS, HS - ESS3.C: Human Impacts on Earth Systems

- Asking Questions and Defining Problems Analyzing and Interpreting Data
- Developing and Using Models

- Cause & Effect
- Stability & Change

ENGINEERING DESIGN

MS, HS - ETS1.A: Defining and Delimiting Engineering Problems
MS, HS - ETS1.B: Developing Possible Solutions
MS, HS - ETS1.C: Optimizing the Design Solution

- 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

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.

KEY VOCABULARY

- **PROBLEM**
Viewed negatively as something difficult to deal with.
- **CHALLENGE**
Viewed positively as a task or situation to overcome.
- **ORGANISM**
An organism is any plant, animal, or other living thing. (**WHO**)
- **ECOSYSTEM**
An ecosystem includes all the organisms in a given area interacting with each other and their physical environment. Biomimicry designs can be inspired both by organisms and the way these organisms interact within ecosystems.
- **TRAIT**
A trait describes a particular characteristic or attribute of an organism. Traits include internal and external structures, physical processes, and behaviors. (**WHAT**)
- **FUNCTION**
A function is an action something does. In biomimicry, function is used to describe what a trait does for an organism. Function can also describe the purpose of a human-made design. (**WHY**)
- **BIOLOGICAL STRATEGY**
A biological strategy describes **HOW** an organism's trait(s) works to perform a particular function.





MOTIVATE

Get inspired! Motivate your team by exploring biomimicry examples. 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.

The storyline begins by introducing learners to the Biomimicry Youth Design Challenge (YDC) and laying out a series of lessons to set a strong foundational understanding of biomimicry concepts and application. Learners preview the YDC website and discuss a video of a winning team's design. Then they explore and apply biomimicry concepts in natural spaces outside their classroom, examine and analyze diverse examples of biomimicry, and connect biomimicry to nature-inspired designs and practices of Indigenous Peoples. The value of nature for, and beyond, biomimicry design is also considered.

LESSONS

- 1 How are students like us designing biomimicry solutions to sustainability problems?
- 2 What is biomimicry, and how can living things give us ideas to solve problems?
- 3 Who are nature's design champions outside our door?
- 4 What is the value of nature and any individual organism?
- 5 How would a biomimicry designer view and describe nature outside our door?
- 6 How do biomimicry designers talk about biomimicry and biological models?
- 7 What can we learn about biomimicry from the nature-inspired designs and practices of Indigenous Peoples both past and present?

GETTING READY

PLAN FOR OUTDOOR ACTIVITIES

Identify a natural outdoor site where students can quietly walk and sit to observe plants and animals. When possible, try to find a place that has natural vegetation (vs. landscaped). If you can't go outside, plan to bring nature into the classroom with natural artifacts (plant parts, seeds, shells, bones, feathers, fur, etc.), videos, or photos.

PLAN FOR DESIGN NOTEBOOKS

Decide on a format for students' Design Notebooks and let them know what to bring to the class. Using a single-class spiral notebook allows them to glue in selected student handouts and activity sheets on one page and free-write/draw on the adjacent page.

REVIEW THE PROGRAM HANDBOOK

This document provides important details about the YDC and what is required to enter the competition. The Handbook is available on the YDC website.

***1 CLASS = 45 MINUTES**

All resources are indexed on the Youth Design Challenge website. To access them, log in at youthchallenge.biomimicry.org and go to the Instructional Storyline page of the Educator Resources.



DRIVING QUESTION:

How are students like us designing biomimicry solutions to sustainability problems?



LEARNING GOAL

Students will be able to describe what they would need to know and do in the Biomimicry Youth Design Challenge (YDC).

WHAT LEARNERS DO

- Begin keeping a Design Notebook for all work related to the YDC. This is a practice of both design engineers and scientists and will be a helpful reference when preparing to enter the YDC competition.
- 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.
- Brainstorm what you need to know and be able to do to be successful in this design project.
- Option: Explore the YDC website together or individually.

WHAT LEARNERS FIGURE OUT

- Past YDC winning projects model what a biomimicry design project could look and sound like.
- Students design solutions to real-world problems in the YDC

LESSON RESOURCES

- YDC Homepage: <https://youthchallenge.biomimicry.org>
- Gallery of past YDC winners' videos: <https://youthchallenge.biomimicry.org/en/custom/ydcgallery/directory>



DRIVING QUESTION: What is biomimicry and how can living things give us ideas to solve problems?

LEARNING GOAL

Students will be able to describe biomimicry in the context of real-world examples.

WHAT LEARNERS DO

- 1 Let students independently figure out what biomimicry is by looking at examples. With students in pairs or triads, show them one image at a time from the inquiry image set, *Biomimicry Examples*, by projecting the images on a screen or making paper copies. Each image shows a pair of photos: a bio-inspired technology and the organism that inspired it (model). Tell them these are examples of biomimicry. Ask them to discuss what they notice about the two photos. After showing several examples, discuss as a class how they would define biomimicry.
- 2 Watch a video introduction to biomimicry with biomimicry pioneer Janine Benyus. (*What is Biomimicry?*)
- 3 Watch a 6-minute video from CBS Sunday Morning that introduces some biomimicry designers and how they are solving problems by learning from nature.
- 4 Summary activity: In small groups, create a graphic organizer (e.g., Frayer Model) of biomimicry understanding to summarize the definition, characteristics, examples, and nonexamples.
- 5 Review the reference *Biomimicry: Description and Key Terms*, and refer to it throughout **MOTIVATE** and the design challenge.

A biomimicry example displaying how a whale fin inspired a wind turbine blade design.



WHAT LEARNERS FIGURE OUT

- Biomimicry is a type of innovation that combines information from biology with the engineering process to design solutions that are inspired by nature's organisms and ecosystems.
- Biomimicry is creating a product, technology, or solution based on how a living thing has solved a similar problem in nature.
- Biomimicry designers study the beneficial traits of organisms and how they work and apply what they learn to create new technologies.

LESSON RESOURCES

Storyline instructional materials:

- *Biomimicry Examples* (images)
- *Biomimicry: Description and Key Terms* (Reference sheet)

Videos:

- *What is Biomimicry?*, from Fast Company & Earth Sky <https://asknature.org/resource/what-is-biomimicry>
- *Biomimicry: Turning to nature for technological solutions*, from CBS Sunday Morning <https://www.cbsnews.com/news/biomimicry-turning-to-nature-for-technological-solutions/>

Teacher resource:

- *Sharing Biomimicry with Young People*, from the Biomimicry Institute <https://asknature.org/resource/sharing-biomimicry-with-young-people/>



DRIVING QUESTION: Who are nature's design champions outside our door?

LEARNING GOAL

Students will connect biomimicry concepts to their observations of organisms living around them.

WHAT LEARNERS DO

- 1 Outdoor Experience: Go outside in a natural space where you can observe organisms in their habitat. Following the guidance in *Nature Solo*, identify and observe nature's design champions that live around you.
- 2 Record observations, insights, and sketches in your Design Notebook.
- 3 Reflect: Look at the image *Two Viewpoints of a Tree*. Compare the two messages and explain which message fits how biomimicry might describe a tree.

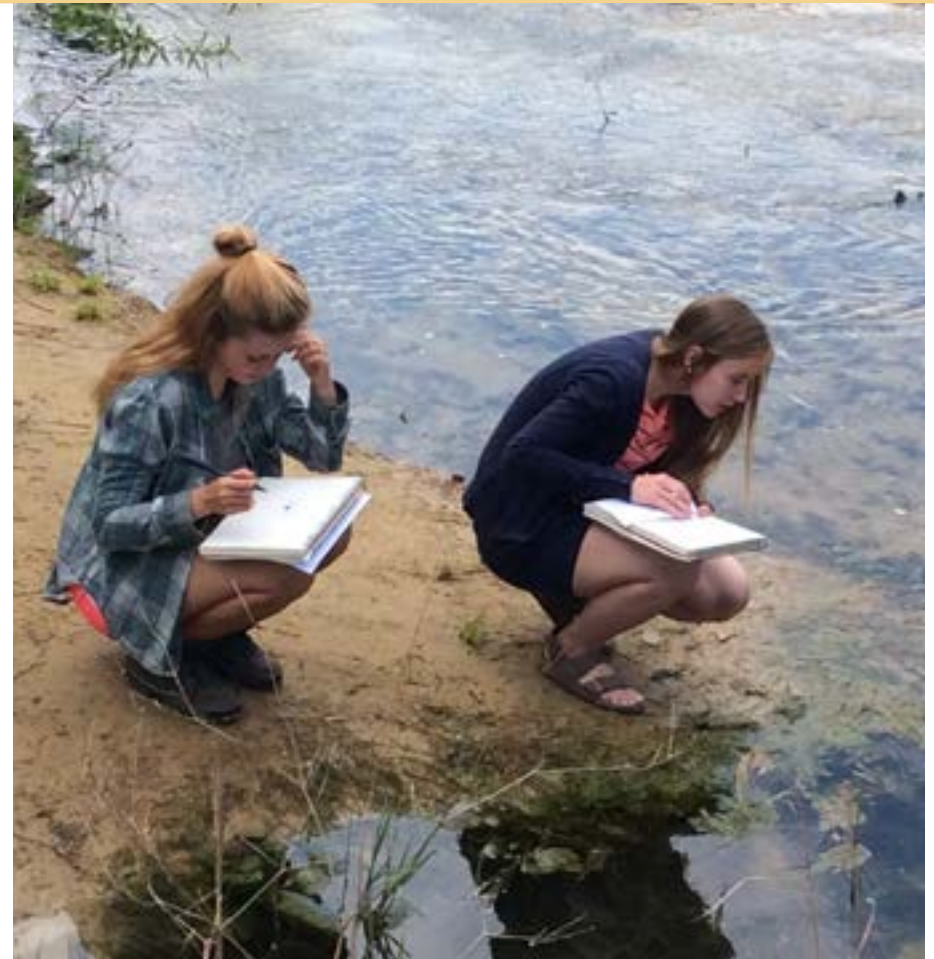
WHAT LEARNERS FIGURE OUT

- Living things have traits that help them adapt to and survive in their environment.
- These traits include internal and external structures, physical processes, and behaviors.
- Most traits function in a way that is helpful to the organism.
- Biomimicry design looks at nature through a trait-function lens.

LESSON RESOURCES

Storyline instructional materials:

- *Nature Solo* (lesson plan)
- *Nature Solo Instructions* (handout)
- *Two Viewpoints of a Tree* (image for activity)





MOTIVATE | LESSON 4

ESTIMATED TIME: 1 class

DRIVING QUESTION: What is the value of nature and any individual organism?



The star-nosed mole provides lots of opportunity for wonder by observing the extraordinary way it navigates its world.

LEARNING GOAL

Students will consider the intrinsic and utilitarian value of nature and defend their viewpoints.

WHAT LEARNERS DO

- 1 View some short videos or listen to podcasts about a variety of nature-inspired solutions created by humans. (*30 Animals that Made Us Smarter*)
- 2 Watch the video, *AskNature Nugget "How does the star-nosed mole sense?"*
- 3 Why does the speaker say that the mole is valuable? Explain and defend your opinion as it relates to the intrinsic and utilitarian value of nature.
- 4 Revisit your field notes for the Nature Solo and respond to "What can we learn from nature's design champions in our region?"

WHAT LEARNERS FIGURE OUT

- Even when an organism has no clearly identified benefit to human innovation, it still has value as a wonder of nature and for its role in ecosystems.
- Every living thing has the potential of someday becoming a source of design inspiration and a model for solving problems and challenges today and in the future.

LESSON RESOURCES

Videos and podcasts:

- *30 Animals That Made Us Smarter*, from BBC
 - Video clips: <https://www.bbc.co.uk/programmes/w13xttw7/clips>
 - Podcasts: <https://www.bbc.co.uk/programmes/w13xttw7>
- *AskNature Nugget: "How do star-nosed moles sense?"*, from the Biomimicry Institute, <https://vimeo.com/46782541>



DRIVING QUESTION: How would a biomimicry designer view and describe nature outside our door?



LEARNING GOAL

Students will go outside to a natural area and examine structures, behaviors, and processes of plants and animals through the lens of function.

WHAT LEARNERS DO

1 Outdoor Experience: Practice observing nature closely and connecting structures, processes, and behaviors observed in organisms with their corresponding function. Follow the guidance of *Exploring Functions in Nature*. **2** Record observations, insights, and sketches in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Biomimicry inspiration is all around us in nature when we slow down and observe closely.
- Almost every organism in nature has traits and strategies we could learn from.

LESSON RESOURCES

Storyline instructional materials:

- *Exploring Functions in Nature* (lesson plan)
- *Function Junction Cards* (activity)
- “Seeing” *Function Observations* (worksheet)



MOTIVATE | LESSON 6

ESTIMATED TIME: 1 class

DRIVING QUESTION: How do biomimicry designers talk about biomimicry and biological models?

LEARNING GOAL

Students will use biomimicry terminology and conceptual understanding to describe a variety of organisms (biological models) and biomimicry innovations.

WHAT LEARNERS DO

- 1 Working in pairs or independently, practice applying biomimicry terminology and concepts by analyzing brief articles, podcasts, and/or videos.

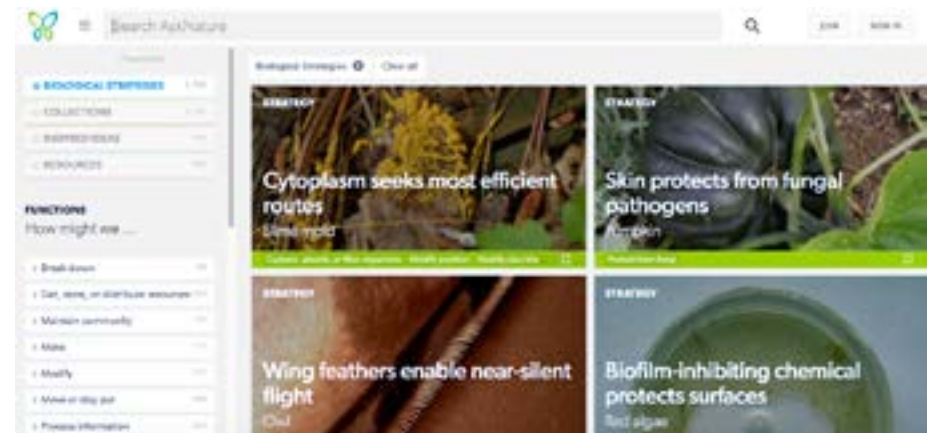
WHAT LEARNERS FIGURE OUT

- Biomimicry designers blend terminology from both biology and design.
- An organism can become a model for a design when it has abilities (traits and biological strategies) that perform the same function a designer or engineer needs their design to do.
- Biomimicry innovations are based on the biological strategies of organisms.
- AskNature.org is a website that organizes biological strategies by function to help biomimicry designers find inspiration for new innovations.

LESSON RESOURCES

Storyline instructional materials:

- “Bio-what?” *The Language of Biomimicry* (lesson plan)
- *The Language of Biomimicry Images* (slides)
- *Biomimicry: Definition and Key Terms* (reference)



Videos, podcasts, and articles:

- *Why Can the Peregrine Falcon Fly So Fast?*, from Boston University. <http://blogs.bu.edu/bioloocomotion/2011/12/12/why-can-the-peregrine-falcon-fly-so-fast/>
- *AskNature Nuggets*, from Biomimicry Institute. <https://vimeo.com/channels/asknaturenuggets>
- *30 Animals that Made Us Smarter* podcast, from BBC. <https://www.bbc.co.uk/programmes/w13xtw7>
- *AskNature Collection: 30 Animals that Made Us Smarter*, from the Biomimicry Institute. <https://asknature.org/collections/30-animals-that-made-us-smarter/>

Other Resources

- *Using AskNature: Guide for YDC Coaches* (reference)
- *Biomimicry Taxonomy Explained* (reference)



MOTIVATE | LESSON 7

ESTIMATED TIME: 1 class

DRIVING QUESTION: What can we learn about biomimicry from the nature-inspired designs and practices of Indigenous Peoples both past and present?

LEARNING GOAL

Students will clarify the connection between traditional nature-inspired innovation by Indigenous Peoples and contemporary biomimicry through examples and explanations.

WHAT LEARNERS DO

- 1 Read and discuss an article describing how different Indigenous cultures have always looked to nature for guidance on how to live and solve problems.
- 2 Extension: Research and gather examples of nature-inspired designs created by generations of Indigenous Peoples.
- 3 Extension: Research and learn about the Indigenous Peoples native to your area.

WHAT LEARNERS FIGURE OUT

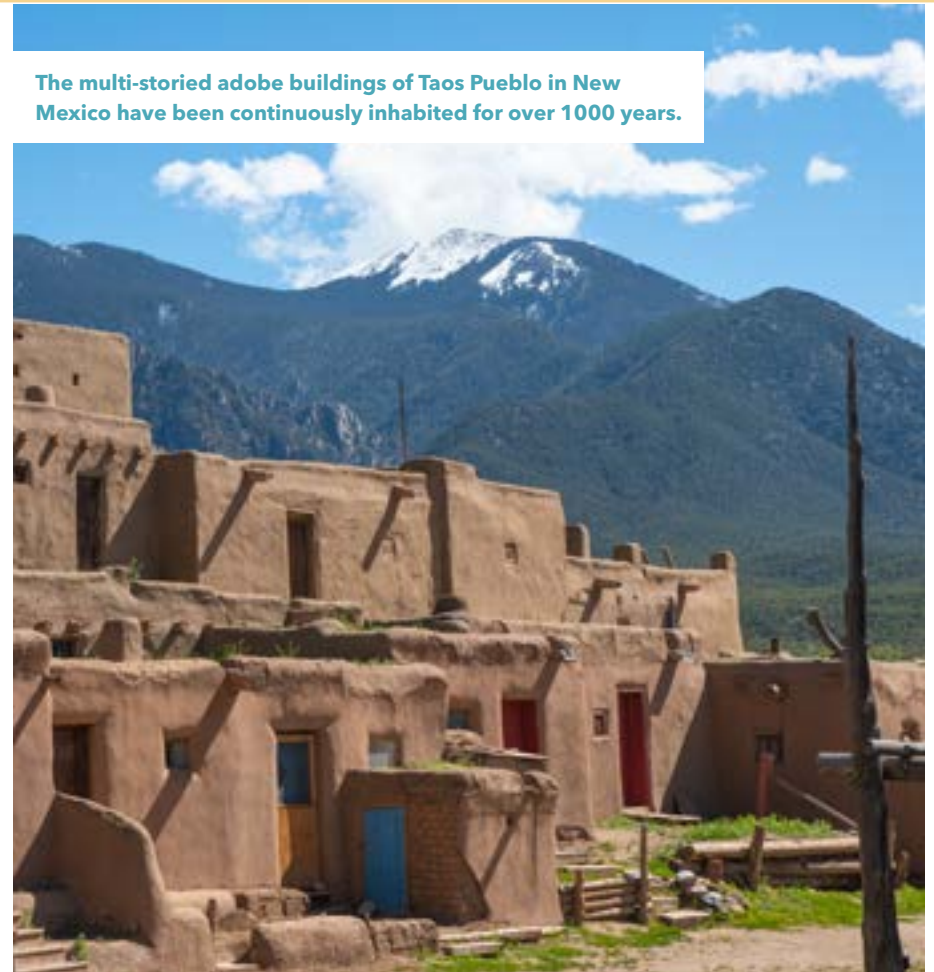
- Biomimicry is as old as Earth's First Peoples and continues to be a foundational part of their Ways of Knowing. Indigenous cultures have always lived in close relationship with nature, seeing it as their model for all innovation, art, and actions.
- The contemporary biomimicry movement follows in the footsteps of nature-inspired Indigenous innovations and is reconnecting other cultures with nature in ways that many have long forgotten.

LESSON RESOURCES

Articles and Resources:

- *Native knowledge: What ecologists are learning from Indigenous people*, from Yale Environment 360. <https://e360.yale.edu/features/native-knowledge-what-ecologists-are-learning-from-indigenous-people>
- *Rediscovering the ancient practice of biomimicry*, from The Modern Ape. <http://themodernape.com/2014/08/26/rediscovering-ancient-practice-biomimicry/>
- List of articles on Traditional Ecological Knowledge and Western Science from the National Park Service. <https://www.nps.gov/subjects/tek/tek-vs-western-science.htm>
- Native land: Learn about the local Indigenous territories around the world. <https://Native-Land.ca>

The multi-storied adobe buildings of Taos Pueblo in New Mexico have been continuously inhabited for over 1000 years.





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.

This sequence of lessons guides learners through steps to define a local problem and to establish the parameters of the biomimicry design they create as a solution. Learners narrow the broad issue of global climate change, the focus of the YDC, by viewing it through the lens of a United Nations Sustainable Development Goal (SDG). The educator/coach has the option of selecting one or more SDGs (aligned with the Next Generation Science Standards) for learners to work with, or letting students choose. Next, students identify a community or regional problem that addresses the chosen SDG. **INVESTIGATE** wraps up with learners considering what their design would need to do to solve the problem and describing the design project's criteria and constraints.

LESSONS

- 8 How could our biomimicry design help solve a problem related to climate change and the UN Sustainable Development Goals (SDGs)?
- 9 What is climate change and how is it affecting our Earth, environment and people?
- 10 What problems in our local area are related to our selected Sustainable Development Goal (SDG)?
- 11 How will we decide which specific problem will be the focus of our design challenge?
- 12 What does our design need to be able to do to solve the specific problem and what are the limitations to our design?

GETTING READY

SDG SELECTION

Review the documents *Connecting the UN Sustainable Development Goals to Climate Change and UN Sustainable Development Goals Aligned to NGSS*. Choose one or more SDGs to be the focus of the design challenge. Ideally, your choice will align with your class educational standards, program theme, and/or a local problem of concern.

DESIGN MATERIALS AND EQUIPMENT:

Begin gathering materials and equipment you want students to use for creating and testing a biomimicry model in Lesson 17. Consider a wide range of options: various building and craft materials, drawing supplies, digital design software, MakerSpace or STEM Labs resources, etc.

Note: Not all innovations require creating a physical or functional model to test their potential. Students can build "looks like" models out of simple materials, or produce detailed drawings and diagrams to communicate their ideas. In the testing stage, these models and images can be shared with knowledgeable experts and stakeholders for feedback.

CHALLENGE RUBRIC AND TEAM SELF-ASSESSMENT

Download and copy the *Challenge Rubric* and the *Team Self-Assessment*. These resources can be used by the educator/coach to guide instruction to meet the criteria for the YDC competition. They will also be shared with students in **INNOVATE** to guide their design process and create YDC submission materials.

DESIGN NOTEBOOKS

Have students continue using their Design Notebook through the problem selection and design process. If they have not set one up yet, let them know what to bring to the class. Using a single-class spiral notebook allows them to glue in selected student handouts and activity sheets on one page and free-write/draw on the adjacent page.

*1 CLASS = 45 MINUTES

All resources are indexed on the Youth Design Challenge website. To access them, log in at youthchallenge.biomimicry.org and go to the Instructional Storyline page of the Educator Resources.



INVESTIGATE | LESSON 8

ESTIMATED TIME: 1 class

DRIVING QUESTION: How could our biomimicry design help solve a problem related to climate change and the UN Sustainable Development Goals (SDGs)?



LEARNING GOAL

Students will set the context for the YDC within climate change issues and the SDGs.

WHAT LEARNERS DO

- 1 With a new understanding of biomimicry, go back to the YDC website to watch and analyze one or more videos of winning student entries. Think from the end to figure out how the previous winning team designed a biomimicry solution that addressed a climate change problem. Identify the steps taken to design the solution. Compare what they did with the Challenge Design Brief.
- 2 Watch one of the call to action videos listed in the Resources.
- 3 Read the Design Brief (description of the design challenge) and discuss how participation in the YDC gives students the opportunity to become part of the global effort to address climate change and create a more sustainable world for all.
- 4 Watch and discuss a video introducing the SDGs.
- 5 Read the fact sheet on the SDG(s) selected for the focus of your design challenge. Brainstorm ideas for possible connection between the SDG and climate change.

- 6 Brain dump:
 - What do you know about issues that are part of the SDG?
 - What are possible connections between the SDG and climate change?
 - What questions do you need to answer about the SDG and climate change that will help with this design challenge? (Questions should be open-ended.)
- 7 Continue recording all information for the design challenge in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Past YDC winning projects model what a student biomimicry project could look and sound like.
- The YDC asks us to create solutions that affect climate change.
- The SDGs are one set of action steps the UN has put in place to help address climate change.
- The SDGs are interconnected. Many of the SDGs affect or are affected by climate change.

RESOURCES

YDC program documents:

- YDC Design Brief (reference)

Videos:

- Past student YDC winners, from the Biomimicry Institute. <https://youthchallenge.biomimicry.org/en/custom/ydcgallery/directory>
- Call to action
 - "'We The People' for The Global Goals". <https://youtu.be/RpqVmvMCmp0>
 - "Secretary-General António Guterres calls for global action on climate change": <https://youtu.be/VNe-jBVij-g>
- About the UN Sustainable Development Goals, from United Nations.
 - <http://www.undp.org/content/undp/en/home/sustainable-development-goals/background.html>
 - <https://sustainabledevelopment.un.org/sdgsummit>

Articles:

- Fact sheets on the SDGs, from United Nations. www.un.org/sustainabledevelopment/wp-content/uploads/2015/08/Factsheet_Summit.pdf



INVESTIGATE | LESSON 9

ESTIMATED TIME: 1 - 3 classes

DRIVING QUESTION: What is climate change and how is it affecting our Earth, environment, and people?

Note: This lesson gives students a basic understanding of the science of climate change and human influence and impact. You can decide how in-depth to go and when you want to teach it. Logical options are including it here, at the end of INNOVATE, or as a separate expanded unit elsewhere in your curriculum or program.

LEARNING GOAL

Students will explain the basic science of climate change, including its causes and impacts on humans and the natural world.

WHAT LEARNERS DO

- 1 Explore one or more of the suggested websites to investigate answers to these questions. Work individually, in pairs, or as a team.
 - Why is the earth warming and the climate changing? (What's the science?)
 - How does human-caused global warming compare to Earth's natural greenhouse effect?
 - Why are people concerned about it? (effects)
 - What are human causes of climate change? (causes)
 - What are people doing to slow climate change? (mitigation solutions)
 - What are people doing to lessen the harm caused by climate change? (adaptation solutions, climate resilience)
- 2 Review your new understanding for connections: What information about climate change relates to your SDG?

WHAT LEARNERS FIGURE OUT

- The causes and effects of climate change are supported by global data from expansive scientific research.
- People around the world are being affected by climate change in different ways.
- People around the world are designing solutions to mitigate or adapt to climate change.
- Working toward the SDG is one way to address the effects of climate change.



LESSON RESOURCES

Videos:

- *Our Climate Our Future*, from Alliance for Climate Education. <https://ourclimateourfuture.org/videos>
- *The Emergent Pattern of Climate Change*, Gavin Schmidt, from TedTalks. https://www.ted.com/talks/gavin_schmidt_the_emergent_patterns_of_climate_change
- *Before the Flood*, from National Geographic. <https://www.beforetheflood.com/>

Websites:

- A Student's Guide to Global Climate Change, from EPA. <https://archive.epa.gov/climatechange/kids/index.html>
- Global Climate Change: Vital signs of a planet, from NASA. <https://climate.nasa.gov/>
- Climate Change Resources page, YDC website (login required). <https://youthchallenge.biomimicry.org/en/page/ydc-climate-change-resources-en>
- Climate Literacy and Energy Awareness Network (100s of vetted educator resources), <https://cleanet.org/index.html>



INVESTIGATE | LESSON 10

ESTIMATED TIME: Partial class (15-30 minutes)

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

LEARNING GOAL

Students will identify and research multiple local problems related to the SDG.

WHAT LEARNERS DO

- 1 Brainstorm ideas for how your SDG is connected to problems in your community or region.
- 2 Organize information about the global SDG and local problems that could be addressed under the SDG. Options include graphic organizers, thinking maps, summary strategies, and outline and note-taking techniques.
- 3 Research several local problems by reading articles, viewing photos or videos, physically exploring your community, and talking with family, community members, or problem stakeholders.
- 4 Choose several problems that you might like to solve with a biomimicry design.
- 5 Continue recording all information for the design challenge in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Each global SDG can be addressed by solving problems in our own community and region.





INVESTIGATE | LESSON 11

ESTIMATED TIME: 1-2 classes

DRIVING QUESTION: How will we decide which specific problem will be the focus of our design challenge?

LEARNING GOAL

Students will use a decision-making process to select a local problem for their design challenge after they analyze and compare several problems and identify variables affecting possible solutions.

WHAT LEARNERS DO

- 1 For each problem selected in Lesson 10, first use the *Problem Analysis* and *Five Whys to the Root Cause* to identify why the problem is happening. This narrows the scope of the problem and solution options. The root cause of the problem(s) then informs the problem statement on the *Problem Analysis*.
- 2 After identifying the key impacts and variables of a potential design for this problem, come up with several responses to the question, "How might we..." This creates a thinking-bridge from the problem to actions that could be taken to solve the problem.
- 3 Discuss and compare the analysis of each problem as a class or team. *[Consider how to give everyone access to all information by sharing paper copies or summarizing the information on a whiteboard, chart paper, or powerpoint slides.]*
- 4 Work through a decision-making process to select the specific problem for your design challenge project.
 - Use a decision-making matrix or finish the sentence "If we choose the problem of [name problem] for our design challenge, then..." for each of the problems by listing the strengths and weaknesses of each. Individuals or small groups could create a persuasive argument for working with a particular problem.

- Make a group decision about which problem the team will try to solve with a biomimicry design.
- 5 Record your thinking process and selected problem in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Problem analysis considers the desired impact and context of a solution to the problem and begins the process of exploring how the problem can be solved.
- The problem first identified may actually be a symptom of another problem. Designing a solution that addresses the root problem will be more effective.
- A decision-making process involves objectively comparing the strengths and weaknesses of the options.
- Working as a team in a collaborative decision-making process means listening to the ideas and opinions of others and being open to compromise. The final team decision should be the best option for the team's interests, goals, resources, and desired impact.

RESOURCES

Storyline instructional materials:

- *Five Whys to the Root Cause* (activity)
- *Problem Analysis* (activity)

Decision-making matrix option:

<https://www.jason.org/wp-content/uploads/2016/05/JASON-Learning-Decision-Matrix-Engineering.pdf>





DRIVING QUESTION: What does our design need to be able to do to solve the specific problem, and what are the limitations to our design?

LEARNING GOAL

Students will define the boundaries (framework) for their biomimicry design using SMARTER design guidelines to set the criteria and constraints.

WHAT LEARNERS DO

- 1 Brainstorm and discuss what you need your solution to do and how it will address the problem.
- 2 Read articles and/or view and discuss photos or videos that describe solutions that have already been tried to address similar problems.
- 3 Begin completing the SMARTER design table by describing how your solution will be a SMARTER design (Specific, Measurable, Action-Oriented, Realistic, Timely, Ethical, Relevant). Write design notes for each of the guidelines.
- 4 Referring to your SMARTER table, complete the *Mapping Criteria and Constraints* activity by listing the must-have criteria that will make your design a success, and the constraints that are limitations for your design process.
- 5 Continue recording all information for the design challenge in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- The design solution needs to perform one or more specific function(s) to help solve the problem.
- Limitations (constraints) and requirements (criteria) set a framework for the design.
- Effective solutions follow SMARTER guidelines.

LESSON RESOURCES

Storyline instructional materials:

- *Mapping Criteria and Constraints* (activity)
- *Is my solution SMARTER?* (activity)



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 solutions to your sustainability problem.

The process of creating a biomimicry design solution begins with the unique steps in **MATCH**. Learners practice “biologizing” their problem to make it possible to search nature for potential solutions. They do this by identifying the fundamental functions that their design needs to do. Then they ask, “How does nature [do that function]?” The final step is for learners to conduct research to identify one or more biological models and analyze which of them can inform their design.

LESSONS

- 13** Which organisms have strategies for solving problems that are similar to the problem we want to solve?
- 14** How will we select the biological strategies that will become our models for a biomimicry solution?

GETTING READY

RESEARCH SUPPORT

Think about how you want to guide and support students in researching biological strategies. Some ideas and online sources are included in Lesson 13. Consider making contacts with local organizations (e.g. zoos, aquariums, nature centers, natural history museums) that may have resources and/or staff biologists and naturalists who can answer questions and share information about interesting organisms with your students. If possible, consider planning a field trip to one of these sites or inviting someone to your class.

*1 CLASS = 45 MINUTES

All resources are indexed on the Youth Design Challenge website. To access them, log in at youthchallenge.biomimicry.org and go to the Instructional Storyline page of the Educator Resources





DRIVING QUESTION: Which organisms have strategies for solving problems that are similar to the problem we want to solve?



LEARNING GOAL

Students will research and gather examples of how nature has solved problems similar to theirs.

WHAT LEARNERS DO

- 1 Recall what you learned about a trait's structure and function in the activities you did in Lesson 5, *Exploring Functions in Nature*.
- 2 Complete the *Biologize the Design Question worksheet* to help you identify functions that you can "ask nature" about.
 - Use your work from the *Problem Analysis and 5 Whys* (Lesson 10) as a reference.

- Transfer your selected response to the "How might we...?" question on the *Problem Analysis and 5 Whys* sheet to the *Biologize the Design Question worksheet*.
 - In the space provided, list simple verbs that describe the basic functions that you need the design to perform. *The Biomimicry Taxonomy* can help with identifying functions/verbs that nature does.
 - List variables (context and conditions) that will affect your design.
- 3 In small groups, play the "*How Does Nature...?*" *Game* to practice translating design problems into research questions that you can "ask nature."
 - 4 Finish biologizing your design. Develop one or more "How does nature [do this function]?" questions. Remember that a "function" is a verb.
 - 5 Using your "How does nature..." question as a guide, research biological models that have strategies for that function. Consider looking for models by:
 - going outside and observing
 - visiting natural history museums, zoos, or aquariums
 - watching wildlife films
 - talking with biologists and naturalists, or other experts
 - reading research articles and journalism about nature
 - exploring AskNature.org
 - 6 Record citations and notes in your Design Notebook, and/or by using the *Inspiring Strategies* reference list, so you can refer back to the information you found. Relevant citations may later be included in your YDC submission.

WHAT LEARNERS FIGURE OUT

- Organisms have diverse traits, most of which help them solve problems that affect their ability to survive and thrive. (Adaptations)
- Traits can be physical structures, behaviors, or processes.
- An organism's trait and how it works to perform a particular function is called a biological strategy.

RESOURCES

Storyline instructional materials:

- *How Does Nature...?* (game)
- *Biologize the Design Question* (activity)
- *Biomimicry Taxonomy* (chart)
- *Inspiring Strategies* (reference List)
- *Using AskNature: Guide for YDC Coaches* (reference)

Websites:

- AskNature Biological Strategies, the Biomimicry Institute. <https://bit.ly/2HNsed9Asknature.org/Strategies>
- AskNature Collections, Biomimicry Institute. <https://bit.ly/2ErVEggAsknature.org/Collections>
- References for Biology Research (Biomimicry Toolbox), Biomimicry Institute. <https://toolbox.biomimicry.org/references/biology-research/>

Web-based STEM expert platforms

- Ask a Biologist, Arizona State University. <https://askbiologist.asu.edu/>
- Nepris (platform for connecting industry experts to classrooms) <https://www.nepri.com>



MATCH | LESSON 14

ESTIMATED TIME: 1-2 classes

DRIVING QUESTION: How will we select the biological strategies that will become our models for a biomimicry solution?

LEARNING GOAL

Students will compare biological strategies to decide which would be most effective to use as models for their biomimicry design.

WHAT LEARNERS DO

- 1 Continue working with *Biologize the Design Question*. Once you have found some biological models, ask “How, specifically, does this organism’s trait/strategy work?”
 - Identify gaps in your understanding.
 - Gather more specific information about how your organisms’ traits/strategies work. Consider using both online or book research, as well as talking with experts in your community or available through web-based scientist chats (e.g., Nepris, Ask a Biologist).
 - Clearly describe how each organism’s traits work to accomplish the needed function (biological strategy), given the specific conditions (i.e., variables) in which the organism lives. Try drawing a picture or concept diagram to help clarify your understanding.
 - Compare the different strategies you found. Do they have anything in common?
 - Determine which organisms’ strategies could become models for your design.
- 2 Select one or more strategies that best match what you want your solution to do.
- 3 Argue from evidence why your strategy(ies) is/are the best model for your design.
- 4 Continue recording your findings in your Design Notebook and *Inspiring Strategies* reference list.

WHAT LEARNERS FIGURE OUT

- Understanding how biological strategies work is important when seeking to mimic them.
- Drawing or creating a diagram of a concept or mechanism can help clarify understandings.
- When many organisms use a similar strategy, this pattern may indicate that it is especially effective or beneficial.
- Evidence can be used to defend why a given organism is a good model for a specific problem.

RESOURCES

Design guides:

- *Biologize the Design Question* (activity)
- *Inspiring Strategies* (reference list)
- *Biomimicry Taxonomy* (chart)
- *Using AskNature: Guide for YDC Coaches* (reference)

Research sites:

- AskNature Biological Strategies, the Biomimicry Institute. <https://bit.ly/2HNsed9Asknature.org/Strategies>
- AskNature Collections, the Biomimicry Institute. <https://bit.ly/2ErVEggAsknature.org/Collections>
- References for Biology Research (Biomimicry Toolbox), the Biomimicry Institute. <https://toolbox.biomimicry.org/references/biology-research/>

Web-based STEM expert platforms

- Ask a Biologist, Arizona State University. <https://askbiologist.asu.edu/>
- Nepris (Connecting industry to every classroom) <https://www.nepris.com>





INNOVATE

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

This is the heart of the design process. Learners begin this biomimicry design phase by translating descriptions of how an organism's strategies perform specific functions into descriptions that can be used in a human-made design. After making this translation with their biological model, learners use these bio-inspired design descriptions to plan, create, test, and refine their biomimicry design. Opportunities are embedded for teams, peers, experts, and stakeholders to offer constructive feedback about the design's effectiveness. As the design process wraps up, learners turn their attention back to the real-world problems that the design was meant to address. Moving from local to global, they evaluate the design's ability to provide a solution to the local problem, while also addressing the global goal to reach the SDG and to help slow or adapt to climate change.

LESSONS

- 15 How can we apply what we know about our biological model to create our biomimicry design?
- 16 How will we ensure our biomimicry design functions effectively to solve the problem we identified?
- 17 How will we test and refine our biomimicry design to improve its chances of success in solving the identified problem?
- 18 How could our biomimicry design contribute to the many projects across the world working to reach the global SDG?
- 19 How does our biomimicry design contribute to global efforts to slow or adapt to climate change?

GETTING READY

DESIGN MATERIALS AND EQUIPMENT:

Be prepared with the design materials and equipment you started gathering before INVESTIGATE. Students will begin using them in Lesson 17 to create and test a biomimicry model. Here is a reminder of what you might consider providing: various building and craft materials, digital design software, MakerSpace or STEM Labs resources, or sketch paper with colored pencils. Remember, not all innovations require creating a physical or functional model to test their potential. Students can build "looks like" models out of simple materials, or produce drawings and diagrams to communicate their ideas. In the testing stage, these models and images can be shared with knowledgeable experts and stakeholders for feedback.

YDC SUBMISSION:

If you plan to submit student work to the competition, refer again to the *Program Handbook* and YDC website to get familiar with the requirements. If you are working with several teams, also begin planning for how you will select the strongest candidates to submit to the YDC competition. To keep the judging process manageable, only three submissions will be accepted per coach. A few ways you can select teams to enter include choosing them yourself, having the class vote, or hosting an event and inviting guests/stakeholder groups to judge the entries.

*1 CLASS = 45 MINUTES

All resources are indexed on the Youth Design Challenge website. To access them, log in at youthchallenge.biomimicry.org and go to the Instructional Storyline page of the Educator Resources.



DRIVING QUESTION: How can we apply what we know about our biological model to create our biomimicry design?

LEARNING GOAL

Students will translate the working principles of their biological models into design strategies and apply them to create a biomimicry design.

WHAT LEARNERS DO

- 1 In small groups, do the *Design-ifying Biological Strategies* activity to practice matching parts of a biological strategy with corresponding parts of a design strategy.
- 2 Apply what you practiced. Make a two-column table and list the key functional elements (body parts, behaviors, processes) of your biological model(s) strategies in one column. In the next column, translate them into words and phrases that express the same idea as a design feature. Use these words and phrases to construct a design strategy that expresses the working principles of the biological strategy. Share these with other teams for a peer review and idea exchange.
- 3 In teams, do the *Biomimicry Brainstorm* activity using the design strategies you wrote in the last step.
- 4 Continue recording all information in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- The language for specific biological strategies can be translated into more general language that captures the underlying working principles that can be used to create a biomimicry design.
- Identifying and describing how a model's biological strategy works requires an understanding of relevant scientific concepts.

LESSON RESOURCES

Storyline instructional materials:

- *Design-ifying Biological Strategies* (activity)
- *Biomimicry Brainstorm* (activity)





INNOVATE | LESSON 16

ESTIMATED TIME: Will vary depending on design (3 - 10 classes)

DRIVING QUESTION: How will we ensure our biomimicry design functions effectively to solve the problem we identified?

LEARNING GOAL

Students will create a model of a biomimicry design that could solve their selected local problem.

WHAT LEARNERS DO

- 1 Work as a team to complete the *Design Challenge Map*. Confirm that your design strategies are aligned with what you learned from your biological model, that the design helps solve the root cause of the problem, and that it addresses the selected SDG and climate change design brief.
- 2 Revisit your SMARTER design table and criteria and constraints map (from Lesson 12) to evaluate your design according to what you described in these design framing documents.
- 3 Complete the *Action Plan* to divide tasks and responsibilities among the team members.
- 4 Read the *Team Self-Assessment* and/or *Challenge Rubric* and keep the criteria in mind during the design process.
- 5 Create your biomimicry design model by following your plan. Visit the *Rapid Prototyping* resource link to get ideas of various ways to create and test models.
- 6 Continue recording your work in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- A project design map, action plan for task management, and SMARTER design descriptions that specify criteria and constraints all work together to provide a framework for the design process.
- Creating a solution to a sustainability problem requires teamwork, flexibility, and creativity.

LESSON RESOURCES

Storyline instructional materials:

- *Design Challenge Map* (activity)
- *Action Plan for Completing Our Biomimicry Design* (activity)

YDC program documents:

- *YDC Team Self-Assessment*
- *Challenge Rubric*

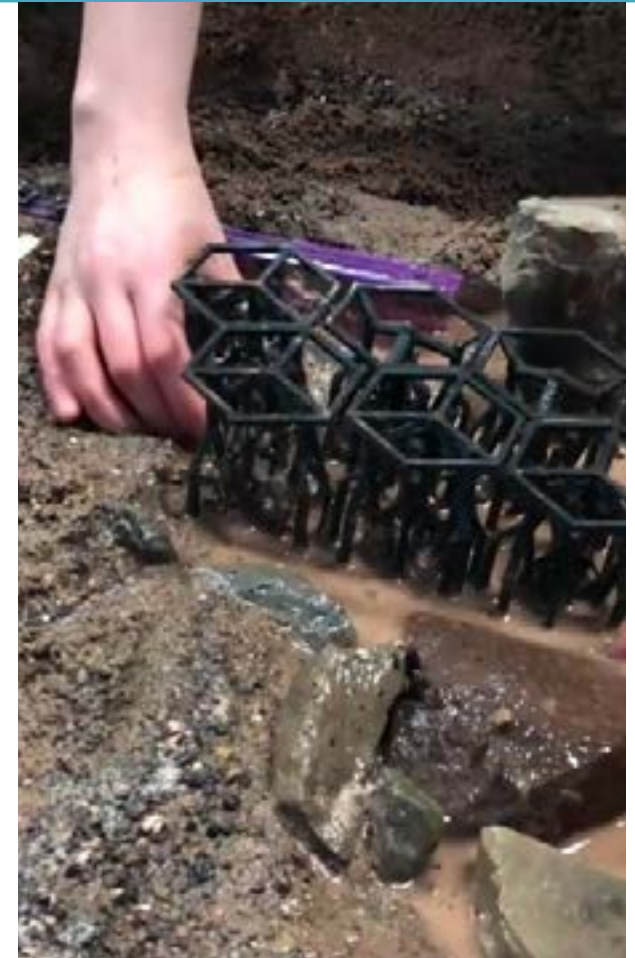
Previous student work:

- SMARTER design tables (from Lesson 12)
- Criteria and constraints maps (from Lesson 12)

Website:

- "Rapid Prototyping", from IDEO.org Design Kit:
<http://www.designkit.org/methods/26>

Materials and equipment needed to create your model.





REFINE DRIVING QUESTION

How will we test and refine our biomimicry design to improve its chances of success in solving the identified problem?

LEARNING GOAL

Students will test their design model and/or get expert or stakeholder feedback, and then use their findings to refine the design and improve its chances of success.

WHAT LEARNERS DO

- 1 Test your design to determine its effectiveness at addressing the problem. Testing methods will vary and could include testing a functional model, assessing a "looks like" model, conducting experiments or tests on parts of the design, and/or creating drawings or diagrams and getting feedback from stakeholders or experts.
- 2 Record observations and data that will help guide you in refining or redesigning.
- 3 As a team, discuss the questions on the *Team Feedback Loop* activity and use responses to guide refinement of your design.
- 4 Share your designs and work-in-progress with peers using the *Peer Feedback Loop* activity.
- 5 Refine or redesign the model to improve its effectiveness at addressing the problem.
- 6 Test your refined design to evaluate its effectiveness at addressing the problem.
- 7 Compare the effectiveness of different designs you tested. Choose the optimal design based on your observations.
- 8 Record your findings, observations, and decisions in your Design Notebook.



WHAT LEARNERS FIGURE OUT

- All designs have both strengths and weaknesses.
- Testing and/or expert/stakeholder review reveals strengths and weaknesses. The purpose of design refinement is to reduce or eliminate the weaknesses and to maintain or increase strengths where possible.
- By comparing the strengths and weaknesses of the refined design with the original design, the most effective design for solving the problem can be determined.

LESSON RESOURCES

Storyline instructional materials:

- *Team Feedback Loop* (activity)
- *Peer Feedback Loop* (activity)

Materials and equipment needed to create your model.



DRIVING QUESTION: How could our biomimicry design contribute to the many projects across the world working to reach the global SDG?

LEARNING GOAL

Students will clarify how their solution to the local problem contributes to global efforts to reach the SDG.

WHAT LEARNERS DO

- 1 Assess and explain how your final design helps solve the root cause of the local problem. Refer to entries in your Design Notebook to inform your thinking. If the design did not clearly solve the problem, describe why and propose changes that could be made to the design to make it a more effective solution to the problem.
- 2 Review the description of the SDG you are addressing. Explain how your design contributes to the global effort to reach this SDG and record it in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Refining the design also requires assessing how a final design aligns with the description of the original problem and the plan for how to solve the problem.
- By working locally to create a solution to a specific problem, people can contribute to the global effort to reach a Sustainable Development Goal.

LESSON RESOURCES

Storyline instructional materials:

- SDG resources from INVESTIGATE

*All papers from the design process in INVESTIGATE, MATCH, and INNOVATE.
Students' biomimicry models*





DRIVING QUESTION: How does our biomimicry design contribute to global efforts to slow or adapt to climate change?

LEARNING GOAL

Students will clarify how their design both helps solve the local problem and contributes to global efforts to slow or adapt to climate change.

WHAT LEARNERS DO

- 1 Option: Rewatch the video of the UN Climate Report call to action by the UN Secretary-General: <https://www.un.org/sustainabledevelopment/climate-change/>
- 2 Review the relevant online resources listed in the reference, *Connecting the UN Sustainable Development Goals to Climate Change*, which describe how the SDGs relate to climate change. Conduct an online search for additional articles and videos describing the connection between the SDGs and climate change.
- 3 In small groups, create a visual representation of how your biomimicry design solution for the local problem contributes to both reaching your chosen SDG and slowing or adapting to climate change impacts.
4. Record or copy your visual representation in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Efforts to reach the Sustainable Development Goals also help to slow the impact of climate change.
- Creating a biomimicry design to solve a local problem and the related SDG can have an additional benefit of reducing the impact of climate change.
- The effects of climate change can be reduced by engaging people all over the world to do small and large actions that address the SDGs.

LESSON RESOURCES

Storyline instructional materials:

- *Connecting the UN Sustainable Development Goals to Climate Change* (reference)





COMMUNICATE

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

If innovative designs are meant to help solve real-world problems and create positive change, they must be shared with others. COMMUNICATE offers a framework to do just that. Before sharing with others, learners reflect personally on how participation in the design challenge affected their own perspectives about concepts and issues, and their confidence in being design engineers and real-world problem solvers. With this personal grounding, learners plan and present their design, its real-world impacts, and the design process they went through to an audience of their choice. The presentation has the option of including components of the YDC submission requirements. The final lesson includes steps for submitting the biomimicry design to the (YDC).

LESSONS

- 20** How has practicing biomimicry shaped how we think about nature, problem solving, engineering, and technology?
- 21** How can we share what we have learned and experienced so others recognize biomimicry as an innovative design process for creating solutions to sustainability problems?
- 22** How do we submit our design project to the Biomimicry Institute's Youth Design Challenge?

GETTING READY

Public Presentation:

Think about, and consider making initial contacts with, local stakeholders who would be interested in hearing about students' projects (e.g., organizations, businesses, agencies, community members, school community).

YDC Submission:

If you plan to submit student work to the competition, refer again to the Program Handbook and website to get familiar with the submission requirements and use them to guide students' final products for COMMUNICATE. If you are working with several teams, make a plan for how you will select the strongest candidates to submit to the competition. To keep the YDC judging process manageable, only three submissions will be accepted per coach. A few ways you can select teams to enter include: choosing them yourself, having the class vote, or hosting an event as part of Lesson 21 and inviting community guests or stakeholder groups to judge the entries.

***1 CLASS = 45 MINUTES**

All resources are indexed on the Youth Design Challenge website. To access them, log in at youthchallenge.biomimicry.org and go to the Instructional Storyline page of the Educator Resources.



DRIVING QUESTION: How has practicing biomimicry shaped how we think about nature, problem solving, engineering, and technology?

LEARNING GOAL

Students will reflect on the design experience individually and as a team.

WHAT LEARNERS DO

- 1 Reflect on what you have learned through this design challenge and how your thinking has changed by responding to prompts in the *YDC Project Reflection*.
- 2 Record your reflections in your Design Notebook.

WHAT LEARNERS FIGURE OUT

- Personal and team insights, understandings, and perspectives have changed after participating in this design challenge.

LESSON RESOURCES

Storyline instructional materials:

- *YDC Project Reflection*





COMMUNICATE | LESSON 21

ESTIMATED TIME: 2-4 classes

DRIVING QUESTION: How can we share what we have learned and experienced so others recognize biomimicry as an innovative design process for creating solutions to sustainability problems?

LEARNING GOAL

Students will present their biomimicry design to a local audience and highlight its potential local and global impacts.

WHAT LEARNERS DO

- 1 Discuss how both you and an audience could benefit from you sharing your design process and innovation.
- 2 Plan a local experience to share and educate others about your design challenge project.
- 3 If you intend to submit your design to the YDC (Lesson 22), review the submission requirements and consider preparing these pieces as part of your local presentation. Refer to the *Team Self-Assessment* as a guide to preparing your presentation and YDC submission pieces.
4. To plan your presentation, refer to *Sharing Our Design Challenge* and consider:
 - Why should you share this information?
 - Who would benefit from hearing what you learned and accomplished?
 - What would you include in your presentation?
 - How would you present how you completed your challenge?
 - Where could you have a gathering (or meeting) to share your challenge?
 - When could this gathering occur?
5. Record your plan in your Design Notebook.



WHAT LEARNERS FIGURE OUT

- A presentation of our challenge is most effective when customized to the audience and thoroughly planned for who, what, how, where and when to communicate and teach about it.
- Sharing an innovative design with those affected by the problem or solution increases the potential impact of the design on the real world.

LESSON RESOURCES

Storyline instructional materials:

- *Sharing Our Design Challenge* (reference)

YDC program documents:

- *YDC Project Portfolio Guidelines and Checklist*
- *YDC Team Self-Assessment*



COMMUNICATE | LESSON 22

ESTIMATED TIME: 2-4 classes

DRIVING QUESTION: How do we submit our design project to the Biomimicry Institute's Youth Design Challenge?

BIOMIMICRY YOUTH DESIGN CHALLENGE



LEARNING GOAL

Students will create a video pitch for their design concept and assemble an award application.

Congratulations! Your team has developed a bio-inspired design solution and now it's time to enter it into the competition. For extended details about the submission requirements and process, please refer to the guidelines on the YDC website and in the Program Handbook.

WHAT LEARNERS DO

1. Prepare the submission materials required to enter the competition.
 - Answers to Project Overview Questions
 - Project Image
 - Project Portfolio
 - Video Pitch
 - Team Photo
2. Review the *Team Self Assessment* to identify where improvement may be needed to make a strong application.

WHAT LEARNERS FIGURE OUT

- Engineers and designers use a variety of methods to communicate their innovative technology ideas to stakeholders and decision makers.

RESOURCES

Storyline instructional materials:

- *Video Pitch Storyboard*

YDC program documents:

- *Program Handbook*
- *Challenge Rubric*
- *YDC Project Portfolio Guidelines and Checklist*
- *Video Pitch Tips*
- *YDC Team Self-Assessment*

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