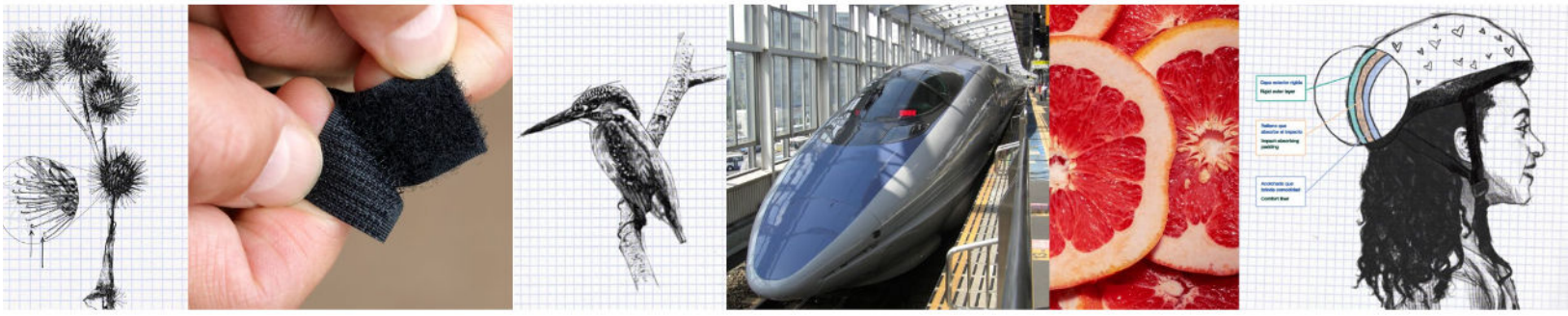

Creatividad SILVESTRE
La biomimesis transformando nuestro mundo

WILD Creativity
Biomimicry changing our world

Staff & Educator Guide

Contents

Acknowledgements

Designing Our Tomorrow: Mobilizing the Next Generation of Engineers (DOT) is a National Science Foundation-funded project carried out between 2018-2024 by the Oregon Museum of Science and Industry (OMSI) and its partners: Adelante Mujeres, the Biomimicry Institute, and the Fleet Science Center. The project seeks to promote and strengthen family engagement and engineering learning via compelling exhibit-based design challenges, which are presented through the lens of sustainable design exemplified by biomimicry.

DOT capitalizes on exhibits as unique family learning environments in the interest of promoting the societal and ecological benefits of sustainable engineering, and fostering intergenerational participation and investment in engineering activities. In the *Creatividad silvestre* | *Wild Creativity* exhibit, families exercise engineering learning together at design challenges that promote sustainable design and biomimicry practices. STEAM belongs to everyone. To help dismantle barriers to equity and access, this project focuses on girls ages 9-14 and their families, and was co-developed with culturally responsive strategies to ensure the inclusion and influence of Latino communities.

The project is structured on OMSI's bilingual exhibit co-development processes and focuses on ensuring cultural and linguistic considerations are integrated into core educational experiences. Through ongoing co-development and co-design processes, the exhibit team used input from partners, advisors, and family members—particularly from Latino communities—to inform the direction of the exhibit, including the narrative, look and feel, 2-D graphics, and exhibit components.

National Science Foundation

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Welcome

This guide provides material for people who want to add facilitation to the *Creatividad silvestre* | *Wild Creativity* exhibit. While the exhibit is designed for visitors to enjoy without facilitation, people may choose to augment the visitor experience with facilitated activities before, during, or after the exhibit visit.

This guide can be used by museum or non-museum staff. The guide offers descriptions of the exhibit and content, plus eight hands-on activity ideas that educators can facilitate. This guide also provides some basic information about how the exhibit and activities can be associated with Engineering and Life Science Next Generation Science Standards for upper elementary and middle school students.

What is *Creatividad silvestre* | *Wild Creativity*?

Creatividad silvestre | *Wild Creativity* is an exhibit that engages visitors in biomimicry, inviting them to design solutions to issues we face in communities around the world using nature as model, mentor, and measure. The exhibit's big idea is: "*Biomimicry engages us with nature's strategies to design solutions for the challenges we face in our own communities around the world*."

In this exhibit, visitors experience the diversity and wonder of nature, learn about the fundamentals of biomimicry, and look to the natural world for inspiration through more than 10 self-guided, hands-on design challenges and interactives. The exhibit copy panels are written in Spanish and English. The exhibit was designed for and with input from 9 - 14 year olds and their families, with a focus to ensure engagement of girls.

About Biomimicry Learning in *Creatividad silvestre* | *Wild Creativity*

This material on biomimicry learning in the exhibit is provided for you to use with your participants. This guide reflects the language used in the exhibit and it has been reviewed by OMSI staff, partners, and advisors.

We are providing the *Spanish* and *English* material as separate printable documents so that you have both to share with your participants.

How is biomimicry defined in *Creatividad silvestre* | *Wild Creativity*?

Biomimicry is an approach to engineering that learns from nature's strategies to help solve human challenges.

What are examples of biomimicry?

Biomimicry can be used to design forms, processes, and systems.

Velcro®

The tiny hooks on some seeds that catch on fabric and fur inspired the invention of Velcro®. Velcro® fasteners easily open and close because they are made with many small loops and hooks like those on the seeds.

Bullet Train

Bullet trains in Japan traveled so fast that they would create a loud "boom" sound as they pushed air out of tunnels. Engineers redesigned some of these trains so the front mimics the wedge-shaped beak of the kingfisher bird. This nature inspired design improvement reduces the buildup of air in front of the trains making them quieter and more energy efficient.

Vertical Wind Turbines

Fish swimming together in schools maintain a consistent space around each fish. Spaced this way, movements in the water created by each fish do not interfere with the swimming of others. This pattern has inspired the design of vertical wind turbines. The turbines are arranged like the schooling fish to make efficient use of space and airflows.

For more information please visit the following websites:
https://asknature.org/innovation/versatile-fastener-inspired-by-burrs/
https://asknature.org/innovation/high-speed-train-inspired-by-the-kingfisher/
https://asknature.org/innovation/wind-farm-design-inspired-by-schooling-fish/

What are the key concepts of biomimicry?

A **function** is the purpose of something—what it does.

A **strategy** is how a function gets done.

To design using biomimicry, match a function—what you want to do—with possible strategies from nature for how to do it[2].

For example:

Function	Potential strategies
Protect	Hide, insulate, fortify
Move	Swim, fly, burrow
Build	Stack, weave, attach
Capture	Filter, absorb, trap

[2]**See more here:**
https://toolbox.biomimicry.org/wp-content/uploads/2015/01/AN_Biomimicry_Taxonomy.pdf

Toolbox website
https://toolbox.biomimicry.org/

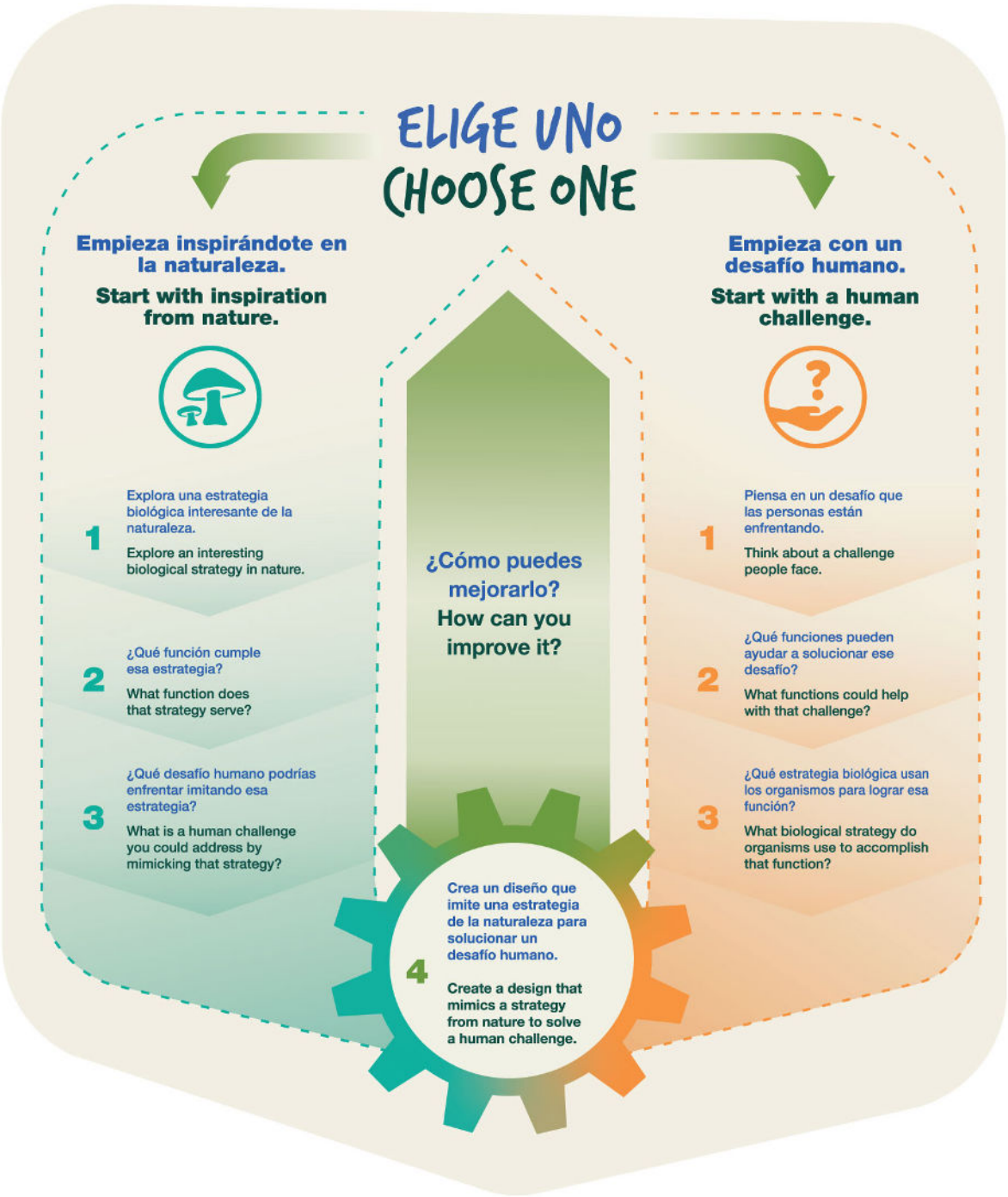
Function/Strategy page
https://toolbox.biomimicry.org/core-concepts/function-and-strategy/

English Taxonomy link:
https://toolbox.biomimicry.org/wp-content/uploads/2021/06/Taxonomy_Explainer_2021.pdf

Spanish Taxonomy link:
https://toolbox.biomimicry.org/wp-content/uploads/2022/08/Biomimicry_Taxonomy_AskNature_Spanish_08-2022.pdf

How is biomimicry done?

People approach biomimicry starting either with a natural inspiration or a human challenge. They then ask themselves a series of questions to decide how to create a design that mimics a strategy in nature to solve a human challenge.



How can biomimicry help our communities?

People around the world are using biomimicry to improve approaches to agriculture, clean energy, transportation, and more. By studying nature's solutions, we can develop innovative approaches like sustainable farming, efficient energy generation, eco-friendly transportation, smart water management, and advanced materials.

Biomimicry, as defined in *Creatividad silvestre* | *Wild Creativity*, is an engineering approach that learns from nature's strategies to solve human challenges. Biomimicry matches functions with strategies to design solutions. Engineers use natural inspiration or human challenges to create designs that mimic nature's strategies.

Biomimicry Institute

For educators seeking a broader range of resources related to engineering and biomimicry, the *Biomimicry Institute*[3] offers a wealth of materials. The website provides educational resources, case studies, and design challenges that integrate biology, engineering, and sustainability. These resources can enhance students' understanding of how natural systems can inspire innovative engineering solutions and foster a deeper appreciation for the interconnectedness of science and nature.

The *Biomimicry Institute*[3] has multiple resources and opportunities for engaging with biomimicry learning. Working with staff and partners like OMSI, the Biomimicry Institute created some resources in Spanish and English, in particular. We recommend the bilingual Collection, *Creatividad silvestre | Wild Creativity*[5], on Ask Nature, which provides information on the functions and strategies of over 40 organisms that can serve as inspiration for design.

About Engineering Learning in *Creatividad silvestre* | *Wild Creativity*

As mentioned above, *Creatividad silvestre* | *Wild Creativity* is an engineering learning experience in the context of biomimicry. This section provides more information for those educators who want to further describe or leverage the engineering learning in the experience.

First, keep in mind that the biomimicry learning described in the prior section, is also about engineering learning. So, please be sure to read that information and include it in your descriptions of engineering learning.

The term engineering is often used to refer to the field of work, or the profession of an

[3] https://biomimicry.org/
Please also see https://asknature.org/educators/ and https://youthchallenge.biomimicry.org/
[5] https://biomimicry.org/
[6] https://asknature.org/collection/creatividad-silvestre/

engineer. However, engineering is also the term for the systematic process of identifying and solving problems through an iterative series of steps. This last definition focuses on the iterative and problem-solving aspects of engineering as a process, and is the definition used for this exhibit. *Creatividad silvestre | Wild Creativity* values engineering broadly, as an approach to problem-solving that includes not only the work of professional engineers, but also strategies and skills that people use, or could use, to address challenges in their own lives and in their communities. By valuing engineering in this way, educators and learners can participate in dialogue about how engineering appears in their lives and their personal actions.

Creatividad silvestre | Wild Creativity was designed so that the hands-on activities in the exhibit are framed in the context of challenges visitors might face in their own communities, and provide opportunities to exercise engineering practices included in the Collaborative Practices at Interactive Engineering Challenge Exhibits (C-PIECE) Framework. *The C-PIECE Framework*[6] is a tool that provides a nuanced lens of engineering design proficiencies, practices, and practice sets to help educators identify new possibilities for activities to foster richer and deeper engagement with engineering design practices at exhibits. The Framework was developed with input from inter-generational families, including girls 9 to 14 years old and members of Latino communities. It was adapted from theory-based constructs of engineering proficiencies and refined using evidence and iterative reviews for use in an informal learning context. The C-PIECE Framework can serve as a starting point for educators and other users of this guide to lead discussions around everyday engineering, and to facilitate interactive engineering activities that promote creativity, critical thinking, and problem-solving skills in visitors of all ages.

References

Randol, S., Benne, M., Herran, C., Ramos-Montañez, S., & Shagott, T. (2021). The C-PIECE Framework: Collaborative Practices at Interactive Engineering Challenge Exhibits—A Graphic Research Summary. Oregon Museum of Science and Industry. https://omsi.edu/for-museum-professionals/designing-our-tomorrow/

[6]https://omsi.edu/wp-content/uploads/2023/02/C-PIECE-Framework-A-graphic-research-summary.pdf
See also: https://engineerourtomorrow.com/wp-content/uploads/2021/07/Exhibit-Features-6-17.21.pdf

Alignment to Next Generation Science Standards (NGSS)

This educational guide is designed to help museum educators and teachers align the exhibit's content and the activities in this guide with the Next Generation Science Standards (NGSS). By incorporating principles of biomimicry and engineering, this exhibit offers a unique opportunity to engage students in the exciting world of science and innovation.

The *Creatividad silvestre* | *Wild Creativity* exhibit offers an exciting and immersive experience for students to explore the intersection of nature, biomimicry, and engineering. By aligning with NGSS, this exhibit and education guide provide educational opportunities for students to broaden their understanding of scientific concepts and engage in engineering design.

By utilizing this supplementary guide, teachers and museum educators can improve the exhibit's educational potential and inspire the next generation of creative designers, scientists, and engineers. The exhibit is designed to captivate and inspire students between the ages of 9 and 14.

The NGSS for grades 4-8 are particularly relevant to this exhibit. The NGSS Engineering and Life Science standards offer the most applicable framework for students to engage with the exhibit's content and activities.

By immersing students in hands-on experiences and interactive displays, the exhibit promotes the exploration of engineering practices aligned with NGSS. For example, students can participate in activities that involve identifying problems, brainstorming solutions, prototyping, testing, and refining designs—a reflection of the iterative nature of engineering.

The activities in this guide invite students to apply crosscutting concepts within the realm of engineering. For example, students can observe patterns in nature and analyze how engineers have used those patterns as inspiration for designing innovative solutions. They can explore the relationship between the structure and function of natural systems and how engineers mimic these features to create sustainable and efficient technologies.

Specific NGSS Domains

Creatividad silvestre | *Wild Creativity* provides consistent alignment with the NGSS by fostering a deep understanding of the practices, crosscutting concepts, and disciplinary core ideas that are fundamental to scientific inquiry. This exhibit particularly emphasizes the following NGSS domains:

- **Engineering Design (ETS)—**The exhibit encourages students to think and act like engineers, as they explore designs and solutions inspired by nature. By engaging with hands-on activities and interactive displays, students can develop their engineering skills. These include: problem-solving, prototyping, and optimizing designs.

- **Life Science (LS)—**Through the lens of biomimicry, the exhibit highlights the interconnections between organisms and their environments. Students will discover how nature has served as a source of inspiration for innovative solutions, and they will gain an appreciation for the diversity of life and its adaptations.
- **Crosscutting Concept: Patterns—**The exhibit encourages students to recognize and analyze patterns in nature and apply them to engineering and design processes. By observing the structures and functions of various organisms, students can identify patterns and apply them to develop innovative solutions to human challenges.
- **Disciplinary Core Idea: Structure and Function—**Through interactive displays and hands-on activities, students explore the relationship between the structures and functions of organisms and their application to engineering. They can investigate how engineers draw inspiration from nature's designs to develop sustainable materials, efficient transportation systems, and other technological advancements.

In this educator guide, we have outlined eight activities that can be utilized in various ways in association with a visit to *Creatividad silvestre* | *Wild Creativity*. Three of these activities are recommended as pre-visit experiences to introduce the notion of function, three are designed for during-visit reinforcement of the exhibit's big ideas. Lastly, two activities are suggested as post-visit-experiences to provide students with an opportunity to practice the planning phase of the design process. Here, we highlight three example engineering standards each from the elementary and middle school levels, along with a crosscutting concept that aligns with the exhibit and these activities.

Elementary School Level

Standard: 4-LS1-1

"Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction."

With the during-visit activities, participants develop a compelling understanding of how these structures play vital roles in supporting the survival, growth, behavior, and reproduction of the showcased organisms.

Standard: 3-5-ETS1-2

"Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem."

This standard relates to the pre- and during-visit activities that reinforce the exhibit's big ideas. Students can explore multiple design solutions presented in the exhibit and compare them based on how effectively they meet specific criteria and constraints.

Standard: 3-5-ETS1-3

"Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved."

This standard is relevant to the post-visit activity that focuses on practicing the planning phase of the design process. Students can apply the concept of fair testing to evaluate their own models or prototypes and identify areas for improvement.

Middle School Level

Standard: MS-ETS1-1

"Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions."

This standard aligns with the pre- and during-visit activities that reinforce the exhibit's big ideas. Students can analyze design problems presented in the exhibit, define criteria and constraints, and consider their impact on both people and the natural environment.

Standard: MS-ETS1-2

"Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem."

This standard relates to the during-visit activities that involve students evaluating and comparing different design solutions based on specific criteria and constraints.

Standard: MS-ETS1-4

"Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved."

This standard connects with the post-visit activity that focuses on practicing the planning phase of the design process. Students can develop and test models to generate data that informs iterative testing and modifications for optimal design solutions.

Crosscutting Concept: Patterns

Students can apply the crosscutting concept of patterns throughout the exhibit and activities by observing patterns in nature and recognizing how engineers use those patterns to inform their designs and problem-solving approaches.

¿Qué es la biomimesis?
What is Biomimicry?

The exhibit entrance orients visitors and offers components that explore introductory biomimicry concepts. Copy includes a definition of biomimicry and examples of common biomimetic designs along with their natural inspirations. A light-up, push-button interactive invites visitors to see examples of useful functions and the natural strategies that achieve them.

Taller comunitario
Community Workshop

This gathering space encourages creative thinking, community building, and exploring more about biomimicry and the people practicing it. Visitors are invited to sit at the workshop table to create their own designs or gather on the bleacher-like seating along the mural wall. Designs can be pinned up to share with future visitors.

La biomimesis en acción
Biomimicry in Action

Visitors explore the work of Biomimicry Institute Design Challenge finalists in this 5–panel component. Five teams of biomimics are introduced in three panels. Every panel has a large book that features team members, the challenge, and their biomimetic solutions. The fourth panel shows videos of the teams.

Community Challenges

Colabora
Collaborate

At this iterative game, visitors are invited to use a touchscreen interface to design a garden that produces the most yield, which can be improved by mimicking natural ecosystems where certain plants are benefitted by growing near one another. Visitors are prompted to place crops in different squares on the digital garden, then improve their design to grow fresh produce for an urban family. After filling the garden with crops of their choice, on-screen feedback offers a yield score encouraging visitors to try again for a higher yield by utilizing biomimetic systems strategy.

Protege
Protect

Visitors select and stack inserts modeled after hedgehog quills, cat paw pads, and pomelo rinds into a cabinet to design a helmet cushion that will protect a bicycle rider. After closing the door, visitors see a hammer fall on their design. Results are displayed as on-screen feedback. Visitors continue to iterate to improve their design and create the safest possible cushion for a bike helmet.

Vuela
Fly

Mimicking natural strategies like flying squirrels, dandelion seeds, and gliding birds, visitors will design, build, and test kite models to generate electricity. Bins provide a variety of materials for visitors to construct a kite that floats in a wind tube. Once visitors connect their design to a test station and push the button, on-screen feedback displays a real-time measure of the energy generated by their kite encouraging visitors to iterate its design.

Nature's Inspiration

Alimenta
Feed

Demonstrating nature's design principle that form follows function, three food gathering tasks challenge visitors to find the right tool for the job. Using oversized models of three bird beaks, visitors attempt to crush a seed, gather nectar, or locate insects and determine which beak is best for each task. Panels show the three birds and describe their particular beak adaptations.

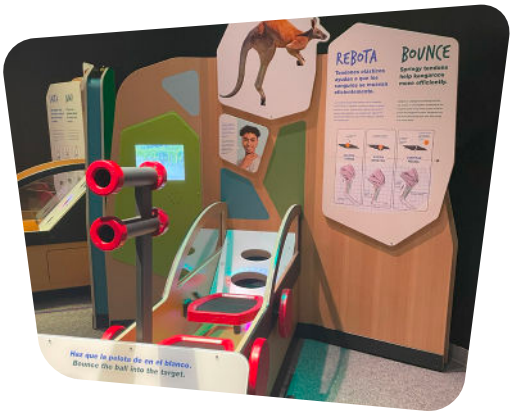
Ventila
Ventilate

There are two "mound" entrances in this exhibit and one wind source. Visitors stack prairie dog tunnel "mounds" of different shapes and heights at the entrances to change airflow within the tunnel. An anemometer indicates the current airflow displayed on a digital readout. Data display is immediate, allowing visitors to quickly improve their mound designs.

Salta
Jump

Mimicking how fleas store and release energy to make big jumps, visitors adjust the angle of the launcher and the amount of tension in the spring to see if they can launch a ball (a flea) to a target (a cat, a dog, or a horse). Visitors iterate to improve their aim and learn about stored energy.

Rebota
Bounce



Visitors adjust the angle of trampolines and select the drop height of a ball to see if they can bounce the ball to one of three targets while learning about how kangaroos bounce to gain energy.

Museum and Classroom Activities

The following activities can complement a visit to *Creatividad silvestre* | *Wild Creativity*. The activity guides are written in English. Any text that is needed for participants is provided in Spanish and English. Where applicable, the activity guides include images to support engagement; they can be printed in color or black and white.

We understand that educators will need to adapt activities to suit their participants' interests and learning goals. We have suggested whether activities might be pre-, during- or post-visit activities, as well as durations and age levels, but most of these activities have a lot of flexibility in all categories.

What is the purpose of these exhibit ancillary activities?

Pre-visit activities

These activities engage participants with the notion of function. Participants could do one or more of these activities prior to their visit to the exhibit.

- **Function Junction:** Introduces function and asks participants to find those functions in nature
- **Bird Beak Design:** Introduces function, plus strategy, as used to fulfill the function in nature and in human design
- **Matching Biomimicry:** Encourages participants to observe characteristics of organisms, including functions and strategies

During-visit activities

These activities engage participants with the intended outcomes of the exhibit experience. If you are interested in doing activities in the exhibit, consider noise level, crowd size, and whether to suggest these activities at the beginning or end of the exhibit.

Creatividad silvestre | *Wild Creativity* has two spaces where educators can facilitate small group activities. You will want to ask a museum educator if these will be available or work with them to ensure there are some spaces to congregate. The first space is a "bleacher-like" seating area where you could congregate for the Salad Bowl activity. The second space is the Workshop where you could congregate for the Community

Improvement activity. Again, you will want to check with the museum staff about the availability of these spaces.

- **Community Improvement:** Encourages participants to create a community improvement design that mimics a function found in nature
- **Wild Creativity Salad Bowl:** Practices learning concepts about the exhibit in a fun and lighthearted way
- **Wild Creativity Exploration:** Encourages participants to explore the exhibit in a hands-on and engaging way

Post-visit activities

These activities provide participants the opportunity to try at least one part of the biomimicry design process, imagining a human challenge that will benefit from the designers' empathy, creativity, and teamwork and looking to functions found in nature for inspiration.

- **Homemade Grabber:** Reinforces concepts learned from the exhibit in engineering and design related to biomimicry
- **Do Biomimicry:** Has participants practice making their own biomimetic design

For educators who would like to further engage their students with the concept of biomimicry, the Biomimicry Institute has an annual biomimicry *Youth Design Challenge*[7] for middle and high school students. The online curriculum takes a hands-on, step-by-step, NGSS-aligned approach to introducing students to the concepts of biomimicry and bio-inspired design. Students engage in a design thinking process and are empowered to propose their own nature-inspired solutions to problems affecting the planet.

[7]https://biomimicry.org/youthdesignchallenge/

FUNCTION JUNCTION

This is a pre-visit activity

Duration: 30-60 mins
Age Range: 6 and up

Activity Description

This activity will engage participants with the notion of function. Each participant will receive a card with a function listed and then explore nature to find examples of that function in one or more organisms. This simple, hands-on activity gives participants practice identifying functions in the biological world and relating them to human design challenges by having them complete a scavenger hunt-style activity.

Materials:

- Use the material in the beginning of this guide to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry and function. You might also tell your participants a little about the exhibit they are going to visit.
- Printed half sheets of the Definitions Section (available in *Spanish* and *English*)
- Slips of paper or preprinted Function Junction cards (available in *Spanish* and *English*)
- A natural outdoor setting that participants can safely explore

Activity Procedure:

1. Plan a route through a natural area that can be completed in 30-60 mins. Try to find somewhere that has a variety of organisms. Some examples include: a river, a lake, a park, a playground, a hiking trail, something that will give you a variety of plants, and evidence of animals. It is important to recognize that not everyone will have access to recreational outdoor areas. If this is the case for you, try to be creative and find examples of nature in your environment.

    - Divide the class into small groups. Explain that you are going to give each team one of the Definitions sheets to use as a reference, as well as one or more cards with a function printed on it. See Definitions section below.

- Tell participants that once they have their function(s) they will work together in their teams to find an example in nature of the given function(s). Either hand each team one (or more) functions, or have a member of each team draw them from the stack or a hat.

  For example, if you had the function "attach" you would look for examples of something in nature that attaches to another thing and the features that enable it to do so.

Tip: Students do not need to know for sure that something is an example of a function. A guess is great, and a discussion can follow.

2. After the participants have had time (10 or more minutes) to explore the area and identify strategies that may be accomplishing their function(s), call participants back together as a class to discuss what they found. Ask for a volunteer to share what their function was and what they found. When a volunteer speaks up, ask that team to lead everyone to the example they found and to explain how they believe the biological structures or processes they identified may help the organism meet the listed function. (The level of detail of the explanation or its accuracy is not important here; the point is for participants to develop an ability to see and speculate about function in nature.)
3. Ask questions such as the ones listed below.
4. Next, ask if any of the other teams found something nearby. Go to the next location and discuss what participants observed. Continue until each team has had an opportunity to share.

Discussion Questions:

- How might you go about learning more about the function or strategies of your organism?
- Are there other strategies used to achieve this function?
- How could this strategy be used to address a human challenge?
- Why do you think it is useful to get out in nature for inspiration?
- What was your favorite thing that you saw today?

Suggestions:

- It can be fun to give all participants the same function (e.g., "stabilize") without them knowing it. The result tends to illustrate how nature can achieve the same function in many different ways.
- When selecting functions for this activity, consider the ecological factors that have influenced the organisms in your area and what functions participants are likely to see. For example, in a fire-adapted ecosystem, have participants look for functions like "resist fire."

Definitions:

A function is the purpose of doing something—what it does.
Some examples of functions include: protect, build, move, and capture.

A strategy is how a function gets done.
Some examples of strategies include: poison, stack, swim, weave, quills, and web.

To design using biomimicry, match a function—what you want to do—with possible strategies for how to do it.

Additional Related Curriculum:

Educators who want to further explore biomimicry in a classroom or afterschool setting can learn more about the Biomimicry Institute's *Youth Design Challenge*[10], which is a hands-on, project-based learning experience for middle and high school students.

[10]https://biomimicry.org/youthdesignchallenge/

BIRD BEAK DESIGN

This is a pre-visit activity

Duration: 20-30 mins
Age Range: 9–14

Activity Description

This activity engages participants with the notion of form and function. This activity encourages participants to observe functions and strategies in bird beaks. The activity also helps learners get into the mindset of developing solutions using natural inspiration as a starting point. Participants describe the qualities of bird beaks to others without having their partner see them. Once the participants have described the qualities of the bird beak they will try to come up with some ideas for how the bird beaks could inspire solutions for human challenges

Materials:

- Use the material in the beginning of this guide to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry, function, and strategy. You might also tell your participants a little about the exhibit they are going to visit.
- Index cards
- Pencils
- Printed images of bird beaks with corresponding beak facts (available in *Spanish* and *English*)

Activity Procedure:

1. Give each participant a blank index card and a pencil.
2. Break out into pairs.
3. Give one person in the pair a copy of Page A bird beak images and the other person a copy of Page B bird beak images, see below.
4. Explain the following
    - Each person picks one bird beak to describe; they will not tell the other person which beak it is. They will take turns describing their beak while the other draws what is being described.
    - They will switch who is drawing and who is describing after 2 minutes.
    - The pairs will sit back to back so they cannot see the other person's drawing.

- The person who is describing the bird beak will only describe using words based on what they think the beak's purpose is or the beak fact corresponding to the bird.

5. Allow 4-5 minutes for this portion of the exercise.
6. Each participant will see if their partner's drawing matches their description.
7. Ask the group:
    - What words best describe the bird beak?
    - What other words might have been helpful?
8. After participants successfully finish the bird beak identification, ask them to pair up in new groups of 2 or 3 and generate ideas for human engineering designs inspired by the bird beaks.
9. Remind them, they need to start with a function served by that beak.
    - For example, this particular bird beak has adapted to grab things from long, skinny spaces. Where do we need to grab things in long, skinny spaces? Perhaps this bird's strategy would be good for reaching things that fall behind the washing machine.
    - Ask them to explain the beak function they identified and the human challenge they identified. Then ask them to explain the tool they imagine designing.
    - Encourage them to be creative!
10. Give participants 5-10 minutes for their conversation and ideas.
11. Lead discussion with questions.

Discussion Questions:

- Why do you think it is valuable to look at nature for design ideas?
- What are some of the human challenges your designs can address?
- What steps might be needed to actually design the ideas on your cards?
- How do tools get made?

References:

Adapted from

Smith (2006). "Smithsonian in your Classroom Activity: Words for Birds." Smithsonian in Your Classroom, Fall 2006. Smithsonian Institution.

Additional Related Curriculum:

Educators who want to further explore biomimicry in a classroom or afterschool setting can learn more about the Biomimicry Institute's *Youth Design Challenge*[11], which is a hands-on, project-based learning experience for middle and high school students.

[11]https://biomimicry.org/youthdesignchallenge/

MATCHING BIOMIMICRY

This is a pre-visit activity

Duration: 15–30 min
Age Range: 9–14

Activity Description

This is a matching activity that engages participants with the notions of function and strategy, as well as human challenges and nature's inspirations. Participants will learn about what sorts of inspirations from nature could influence designs in engineering. Participants can make a case for why they think a specific design could be influenced by an inspiration from nature.

In general, the goal is to match a Challenge card with one or more Strategy cards that could inspire an innovative, sustainable solution to the design challenge. There are many ways to do this! You could play in a collaborative group by dealing out the Strategy cards among players and piling the Challenge cards face-down in the middle. Draw a Challenge card for the group and read it aloud. Then, each player looks at their Strategy cards and tries to match a Strategy to the Challenge. Discuss each player's suggestion within the group, explaining how the Strategy and Challenge are connected.

You can also play this game individually, matching as many Challenges and Strategies as you can. Or, you can start with a Strategy card and pick the Challenge card(s) that the Strategy could help solve. Many Challenge cards will match with more than one Strategy. The "Suggested Matches" card lists potential matches between cards, but feel free to be creative with your matches. You can also create your own Challenge and Strategy cards using the "Wild Cards" as a guide and a place to attach small sticky notes with drawings and writing.

Materials:

- Use the material in the beginning of this guide to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry, function, and strategy. You might also tell your participants a little about the exhibit they are going to visit.
- Printed cards from *Biomimicry Institute*[12] (Available in *Spanish* and *English*)
- Discussion Questions
- Internet Access (optional)
- The following links (optional)

[12]https://biomimicry.org/

- https://asknature.org/biological-strategies/
- https://asknature.org/collection/creatividad-silvestre/
- https://asknature.org/es/collection/omsi-exhibit/

Activity Procedure:

1. Prior to the activity, participants look at examples of functions and strategies from nature available in Spanish and English here.
2. Explain that they will be matching each Challenge card to a possible solution in nature (Strategy card) they think matches.
3. Let participants know that there can be multiple answers or matches. Challenge them to find as many as they think are relevant.
4. Shuffle the challenge cards and place them face down on the table.
5. Gather around and have each participant select a Challenge card, and then go through the Strategy cards to see which ones they think could be mimicked to help solve that challenge.
6. According to the age group playing, you can have discussions on why they think the Strategy in nature could help solve the engineering Challenge.

Tip: Remind participants that they may have to think creatively about the concept and why it matches. Ask follow up questions, and do not focus on why they may be wrong, but how it is possible to make their ideas work.

Suggested Matches:

- Radon: Termites, Black-tailed prairie dog
- Weather extremes: Thomson's gazelle, Reindeer, Alaskan darkling beetle, Black-tailed prairie dog
- Off-grid home: Oriental hornet, Olive tree, Tammar wallaby, Rainbow trout, Social insects
- Water treatment: Wetland, Aquaporin, Dromedary camel
- Digital displays: Chameleon, Morpho butterfly
- Durable materials: Nacre, Striped bass, Golden-scale snail, Photosynthesis
- Polymers: Photosynthesis, Bacteria
- Clean surfaces: White rock shell snail, Lotus leaf
- Wind power: Harbor seal, Owl, Rainbow trout
- Cargo ships: Water fern, Harbor seal, Social insects
- Water supply: Namib darkling beetle, Dromedary camel
- Vaccine storage: Tardigrade
- Agriculture: Tallgrass prairie
- Surgical glues: Blue mussels
- Earthquakes: Venus' flower basket

Discussion Questions:

- Why do you think it benefits humans to mimic nature?
- What does a function mean in your own words?
- Were there any of these natural inspirations that surprised you? Why?
- Can you think of any other ways that nature has inspired people to make something interesting?
- Can you think of any new ways to mimic nature in your daily life?

Additional Related Curriculum:

Educators who want to further explore biomimicry in a classroom or afterschool setting can learn more about the Biomimicry Institute's Youth Design Challenge[13], which is a hands-on, project-based learning experience for middle and high school students.

[13]https://biomimicry.org/youthdesignchallenge/

COMMUNITY IMPROVEMENT TEAM CHALLENGE

This is a during–visit activity

Duration: 20-40 min
Age Range: 9–14

Activity Description

The objective of this activity is to encourage participants to find inspiration in the exhibit and apply ideas and solutions to issues that may come up in places like their neighborhoods, homes, apartment buildings, neighbors' homes, schools, or community centers. This activity helps to engage participants by encouraging them to look to nature for strategies to resolve challenges in their communities.

The big idea of the exhibit, *Creatividad silvestre* | *Wild Creativity*, is: Biomimicry engages us with nature's strategies to design solutions for the challenges we face in our own communities around the world.

Modification for additional audiences:

If you want to make this activity easier and shorter, you can suggest participants work on challenges specifically related to home heating, cooling, and ventilation, because the exhibit has clear tips related to those challenges. When participants search the exhibit, they will find ideas on these topics at the exhibits: Ventilate (Prairie Dogs), Cooling our Cities, Nature's Principles, and AskNature.

Materials:

- Use the material in the beginning of this guide to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry, function, and strategy. You might also review the design process graphic with your participants.
- *Creatividad silvestre* | *Wild Creativity* exhibit
- Images of a house in the snow or wind, a building in the hot sun, a door, a leaky ceiling, a broken potted plant, find examples *here*
- Drawing utensils
- Poster board (optional)

Activity Procedure:

1. Participants break out into groups of 2-4
2. *Optional: Participants can take on roles like timekeeper, note-taker, illustrator, facilitator*
3. Participants are presented with the images or a list of challenges they might find in buildings in their community. They choose one they want to address.
4. Participants identify the function they need to achieve to fix their problem.
5. Ask participants to observe nature to find strategies, or inspirations for strategies, to serve that function by looking for examples in the exhibit. Participants will look for functions and strategies among plants, animals or fungi.
6. Let them know that they will:
    a. Identify the problem. Why is this an issue? What will happen if this goes unaddressed?
    b. Identify the function needed to address the problem.
    c. Identify at least one living being with a particular strategy that meets the function identified and which can inspire a solution for the building challenge.
    d. The exhibit has many examples including an AskNature collection.
    e. Describe how the solution would work.
    f. Sketch a version of their solution.
7. Once participants have identified these things they will transfer their work to their posterboard.
8. Let them know they will be sharing back.
9. Encourage them to be creative!
10. Give them 10-15 minutes to complete their plan.
11. Once they have drawn out their plan encourage them to share with guided discussion.

Tip: Make sure you are being sensitive to issues about home ownership, homelessness, and housing instability when doing this activity. Do not make assumptions about people's experience fixing things in their home.

Discussion Questions:

- What other things do you think you could fix with the solution you came up with?
- How much time do you think this would take?
- Would your solution be easier or cheaper or more sustainable than doing it a different way?
- How would you test this solution in your home?

WILD CREATIVITY SALAD BOWL

This is a during-visit activity

Duration: 15–30 min

Can be adapted to be shorter or longer depending on the level of interest. Explaining rules and setup should be about 5-10 minutes. Each round takes 10-15 minutes

Age Range: 9–14

Activity Description

This activity is a drawing and charades game where players take turns drawing a picture that represents a phrase related to the exhibit. If another player guesses the word correctly, their team gets a point. This activity will engage participants with the intended outcome of the exhibit experience which is to capture the exhibit's big idea, "Biomimicry engages us with nature's strategies to design solutions for the challenges we face in our own communities around the world."

Materials:

- Use the material in the beginning of this guide or in the exhibit to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry, function, and strategy. You might also review the design process graphic.
- 1 sheet of paper per participant
- 1 strip of paper per participant
- Drawing and writing utensils
- A bucket, hat, or bowl

Activity Procedure:

1. Hand out a strip of paper to each participant and a writing utensil.
2. Explain to participants to write 2-3 short phrases on different strips of paper that are an example of a function and/or strategy from the exhibit, for example, a human challenge and an inspiration from nature.
3. Encourage them to take a look around the exhibit for inspiration. Some examples include "Ventilating a home like a prairie dog" or "Collecting water like a spider web."
4. Give them 5 minutes to select their short phrases.
5. Once they have written 2-3 short phrases on their strips of paper, they will fold the strips and put the strips in a hat, bucket or salad bowl.
7. Shake this container.

8. Let them know that the object of the game is to guess as many correctly as possible.
9. The whole group will work together to guess each of the prompts.
10. Each member of each team will take turns pulling a strip from a hat and either acting it out or drawing it.
11. They will each have 30 seconds and cannot write words or speak.
12. If the phrase is guessed correctly by their team they win a point.

Discussion Questions:

- Were there any phrases that were easier or harder to act out or draw than others?
- Did you see any patterns in the types of phrases that people picked?

WILD CREATIVITY EXPLORATION

This is a during visit activity

Duration: 35–60 min
Age Range: 9–14

Activity Description

This activity is an interactive way to explore the concepts of biomimicry and engineering. With this activity, participants will navigate the exhibit, discover examples of biomimicry, and deepen their understanding of how nature inspires innovative solutions to human challenges.

Materials:

- Exploration challenge sheet (available in *Spanish* and *English*)
- Writing utensils
- Smartphones or cameras for participants to document their findings (optional)

Activity Procedure:

1. Gather the participants and provide an overview of the Exploration activity and its objectives.
2. Explain that the Exploration Sheet will be used within the exhibit, where students will search for specific exhibit experiences, answer questions, and complete challenges.
3. Emphasize the value of teamwork, observation skills, and critical thinking throughout the activity.
4. Provide each team with a copy of the Exploration Challenge Sheet.
5. Ensure that each team has access to writing utensils to write notes on the sheet.
    - Alternatively, you can encourage participants to use smartphones or cameras for documentation (optional).
6. Instruct participants to explore the exhibit, search for the answers to the questions, and complete the interactive tasks.
7. Encourage collaboration within each team, fostering discussion and sharing of insights.

8. Circulate among the teams to provide guidance, answer questions, and ensure they stay on track.
9. Gather the participants together after completing the Exploration.
10. Facilitate a group discussion using the following questions.

Discussion Questions:

- What were some interesting examples of biomimicry that you discovered in the exhibit?
- How do you think biomimicry can contribute to solving real-world challenges?
- How did the interactive challenges help deepen your understanding of engineering and sustainable design?
- Did you think any part of the Exploration was challenging? What was the issue? How did you overcome it?
- How did working in teams enhance your experience during the activity?

HOMEMADE GRABBER

This is a post-visit activity

Duration: 60 min
Age Range: 9–14

Activity Description

This activity engages participants in the design process using empathy for human challenges and inspirations from nature for design.

Materials:

- Use the material in the beginning of this guide to orient your participants, as you think helpful. For example, you might provide the definitions of biomimicry, function, and strategy. You might also provide the design process and go through that with your participants.
- Examples from nature of effective grabbers like octopus arms, hero shrew spine, mantis pincers, squirrel claws, elephant trunk, lizard tongue
- Straws
- Sheets of paper
- Sheets of cardboard
- Brads
- Scotch tape
- Glue/Hot Glue
- Scissors
- Yarn or string

Activity Procedure:

1. Explain that participants will build a grabber that they will use to pick something up; this will be inspired by different kinds of strong and flexible structures in nature.
2. Have participants look at examples of naturally strong and/or flexible grabbers or physical structures in nature. These could include things like:

Octopus arms

Osprey claws

Mantis pincers

Squirrel claws

3. Let participants know they can look for other inspirations in nature that would work well for their flexible grabber.
4. Have participants brainstorm how a grabber tool could help people in their community solve everyday problems.
5. Have participants build their grabber with the provided materials.
6. Have them attempt to pick something up with their articulating grabber.
7. Assist participants as needed, but try to challenge them to identify their design challenges.
8. Facing challenges and overcoming them in this design challenge is part of the process.

Tip: Be mindful when making analogies in comparing these grabbers with prosthetic devices. This activity is fun, but is not meant to make light of struggles people have with disability.

9. Once participants have assembled their grabber have them discuss their experiences.

Discussion Questions:

- What challenges did you come across with the style of grabber you picked?
- Does anyone think one style of grabber is better than another for grabbing things?
- What was hard about this activity?
- What did you like?
- What human challenge did you choose to address?
- What organisms inspired your approach to design?
- What about your design seems promising?
- If you were to keep improving your design, what might you try next?

DO BIOMIMICRY

This is a post-visit activity

Duration: 30–60 min
Age Range: 9–14

Activity Description

In this module, participants will engage in a biomimicry activity inspired by OMSI's *Creatividad silvestre* | *Wild Creativity Exhibit*. They will either start with natural inspiration and apply it to a human challenge or start with a design challenge and look to nature for strategies to address the challenge. Participants will have the opportunity to match challenge and inspiration cards or use *Creatividad silvestre* | *Wild Creativity* to spark their ideas. They will then draw their biomimetic designs, fostering innovation and a deeper understanding of nature's solutions.

Materials Needed:

- Biomimicry inspiration and challenge cards (*Spanish* / *English*)
- Activity sheet (*Spanish* / *English*)
- Drawing materials (pencils, colored pencils, markers, etc.)
- Access to *Creatividad silvestre* | *Wild Creativity Exhibit* optional
- Projector/screen (optional for displaying challenge and inspiration cards)

Activity Procedure:

1. Distribute biomimicry challenge cards and inspiration cards to participants. Alternatively, project the cards on a screen for group viewing.
2. Encourage participants to explore the challenge and inspiration cards, looking for one that resonates with them.
3. If available, direct participants to use OMSI collection for additional information.
4. Provide activity sheets and have participants individually or in pairs fill in the function, strategy and challenge information.
5. Let them know that they can match the card they selected with a corresponding card or come up with their own ideas.
6. Encourage participants to sketch their biomimetic design that utilizes a natural strategy to solve a human challenge.
7. Emphasize creativity and innovation, encouraging participants to think outside the box.

8. Allow participants to share their designs with the group.
9. Facilitate a brief discussion about the diverse designs and strategies created.
10. Reflect on the process of using nature's strategies to solve human challenges.

Discussion Questions:

- What aspects of nature's designs were particularly inspiring for your biomimetic design?
- Did the AskNature website help you discover new ideas? How did it influence your design?
- How does thinking about nature's solutions change the way you approach human challenges?
- How can the concept of biomimicry contribute to sustainable innovation and problem-solving?