The Language of Biomimicry

How do biomimicry designers talk about biomimicry and biological models?

Biomimicry designers—and tools created for them, such as AskNature—use terminology that blends biology and design. In this lesson students will work individually or in groups to analyze AskNature Biological Strategy pages and practice applying biomimicry terminology to describe their components and core concepts.

Duration: 45 minutes

Objectives
- Students will use biomimicry terminology and conceptual understanding to describe organisms (biological models) and biomimicry innovations.

Materials
- Student notebook and writing utensils
- Biomimicry: Definition and Key Terms (attached) - one copy per student or group
- Individual devices or projector

Standards Addressed
Next Generation Science Standards (NGSS)

Disciplinary Core Ideas
- MS-LS1.A: Structure and Function: In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.
- HS-LS1.A: Structure and Function: Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.

Science and Engineering Practices
- Constructing Explanations and Designing Solutions

Crosscutting Concepts
- Structure and Function
- Patterns
Background
The biomimicry design process requires designers to be comfortable using the language of both biology and design. Biomimicry designers must be able to identify functions within their design problem. They can then look for inspiration at how nature has addressed the same functions. In order to identify potential biological inspiration, biomimicry designers must be able to identify and describe the functions of organism traits (structures or behaviors), and how they work (strategies).

Activity
1. On an individual, or a projected classroom device, visit the AskNature Biological Strategy Page “Baleen Plates Filter Food: Blue whale” Ask students to read through the contents of the page. (https://asknature.org/strategy/baleen-plates-filter-food/).
2. Ask students the following questions one at a time, and have them discuss their ideas in pairs, triads, or a full group.
   - What have baleen whales evolved to do well? (filter food from seawater)
   - What body structures help them filter food from seawater? (baleen)
   - How, specifically, does their baleen help them filter food? (The whale’s upper mouth is lined with baleen. The whale takes in a mouthful of seawater containing krill. It then closes its mouth and forces the water out through the brush-like baleen, keeping food inside.)
   - How have engineers used the whale’s baleen as a model for designing technology? (self-cleaning water filtering system cleans without chemicals)
3. Create a 2-column table for class discussion and have students do the same in their notebooks.

<table>
<thead>
<tr>
<th>Biomimicry Term</th>
<th>Organism</th>
<th>Trait</th>
<th>Function</th>
<th>Biological strategy</th>
<th>Human design application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomimicry Term</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_______________ [is / could be] a biological model for the design of ______________.
4. Hand out Biomimicry: Definition and Key Terms to each student if they don’t have a copy already. Work through the chart together, using the handout to determine definitions of the biomimicry terminology. Review the words that students may already be familiar with (organism, ecosystem, trait, function). Discuss terms that are new. Work as a group to decide what to put in the Baleen whale column for each term.

<table>
<thead>
<tr>
<th>Biomimicry Term</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organism</strong></td>
<td><strong>Blue Whale</strong></td>
</tr>
<tr>
<td><strong>Trait</strong></td>
<td><strong>Baleen (brush-like keratin structure in the whale’s mouth)</strong></td>
</tr>
<tr>
<td><strong>Function</strong></td>
<td><strong>Filters food</strong></td>
</tr>
<tr>
<td><strong>Biological strategy</strong></td>
<td><strong>When a baleen whale consumes a huge mouthful of krill, small fish, and water, it partially shuts its jaws and then presses its tongue against its upper jaw to force the water through the baleen, leaving the krill and fish on the inside of the filter for the whale to swallow.</strong></td>
</tr>
<tr>
<td><strong>Human design application</strong></td>
<td><strong>Water filter</strong></td>
</tr>
</tbody>
</table>

*Baleen is a biological model for the design of water filters.*

5. Next, ask students to navigate to the AskNature Biological Strategy page about Jackrabbits (“Large Ears Help Cool : Black-tailed jackrabbit”, https://asknature.org/strategy/large-ears-used-to-cool-off). Work with students to break down the statement about the Jackrabbit to fill in the first sections of their chart.

6. Have them create a table, like the one for the baleen whale, that matches the terms with descriptions of the rabbit.
<table>
<thead>
<tr>
<th>Biomimicry Term</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Organism</td>
<td>Jackrabbit</td>
</tr>
<tr>
<td>Trait</td>
<td>Large ears</td>
</tr>
<tr>
<td>Function</td>
<td>Cooling</td>
</tr>
<tr>
<td>Biological strategy</td>
<td>Radiating heat via an extensive network of blood vessels in the large ears.</td>
</tr>
<tr>
<td>Human design application</td>
<td></td>
</tr>
</tbody>
</table>

7. Students will notice that there is not a page for an Innovation as there was for the whales. Ask students to think about problems they might solve using the cooling function of the rabbit’s ears, and come up with ideas for a human design application that utilizes the same function.

8. Ask students to navigate to the home page of the AskNature website (AskNature.org). Explain that this website describes over 1,700 biological strategies and nearly 200 technology innovations, all organized by function. The key terms they have been practicing will help them understand the content on the website.

Evaluate

- Have students independently choose another Biological Strategy page and complete a similar chart.

Extension Opportunity:
Have students review brief articles or videos about biomimicry innovations and practice identifying the biological strategy that was mimicked and applying biomimicry terminology to describe them.
Biomimicry: Definitions and Key Terms

What is Biomimicry?
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.

How Does Biomimicry Happen?
Biomimicry designers study the beneficial traits and functions of organisms as biological models to inspire sustainable design solutions. They also may study how organisms interact with each other and their environment within ecosystems and apply what they learn to create better processes and systems.

When approaching a design challenge, biomimicry designers look for organisms and ecosystems in nature that have already ‘solved’ a similar problem over millions of years of adaptation and evolution. Then they study how the traits of these organisms work and apply what they learn to the design of new human technologies.

Biomimicry designers begin by finding a match between what their design solution needs to do (its function) and similar functional needs that organisms have. Often, they do this by looking for organisms that live in a context or conditions that are similar to those in which the design solution will be used. For example, people in hot climates need ways to keep the interior of buildings at a comfortable temperature. Keeping cool, or managing temperature, is a function. Many animals living in the desert also need ways to keep their bodies or burrows cool. These animals have developed a variety of strategies for doing so via adaptation. By researching how desert animals keep cool (that is, their biological strategies), biomimicry designers have created design strategies for cooling homes and other buildings.

Key Terms:
- **Organism**: An organism is any plant, animal or other living thing.
- **Trait**: A trait describes a particular characteristic or attribute of an organism. Traits include internal and external structures, physical processes, and behaviors.
- **Function**: The 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.
- **Biological model**: A biological model is any organism or ecosystem, along with its associated strategies and traits, that a biomimicry designer seeks to mimic/emulate.
- **Ecosystem**: An ecosystem includes all the organisms in a given area interacting with each other and their physical environment.
- **Biological strategy**: A biological strategy describes HOW an organism’s trait(s) works to perform a particular function.
- **Design strategy**: A design strategy describes how the feature(s) of a design or technology work to produce a desired function.
- **Context**: The interrelated conditions in which something exists or occurs. In biology this includes the environment and other conditions affecting an organism and influencing the development of its adaptive traits. In design this includes the criteria, constraints, and any factors or considerations affecting the success of a design solution.