In the previous lesson (Lesson 2: Identify the Design Challenge), students developed design questions to guide their design process. This presentation uses several examples to support students' understanding of how to translate or "biologize" those design questions in order to develop a "How does nature…" research question. This important step makes it possible for us to begin looking to nature for strategies to solve specific design problems by uncovering analogies between what we want to do with our designs and things that nature already does.

Presentation Objectives:

- Explain how looking to nature for ideas is what makes biomimicry unique.
- Describe how to translate design problems into biology research questions and why that process is helpful.
- Describe how function and strategy link design and biology.
- Demonstrate how to identify biologically relevant functions and contexts within a design challege.

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Getty Images 499913015: SeventhDayPhotography: Shy red fox behind a tree

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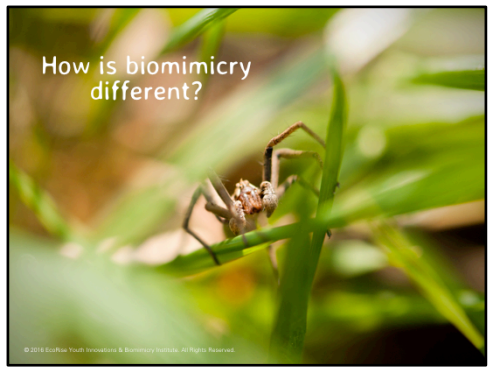

Objective:

- Explain how looking to nature for ideas is what makes biomimicry unique.

Suggested Teaching Strategy:

Tell students that the work they've done so far—identifying a design question, criteria, and constraints—is not unique to biomimicry. It's fundamental to good design thinking and problem solving. But the next step we will talk about IS unique to a biomimicry approach. It is this next step that makes it possible to begin looking to nature for strategies to solve specific design problems.

Encourage students to guess what this next step might entail. *(Accept all answers and move to the next page.)*

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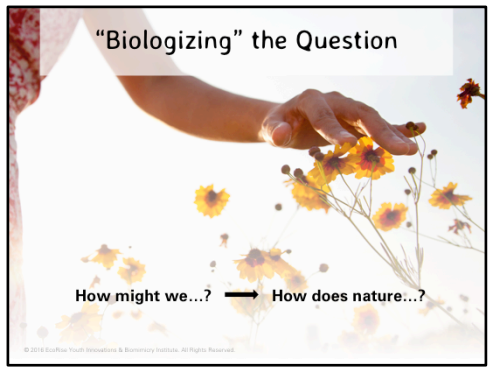

Objective:

- Describe how to translate design problems into biology research questions and why that process is helpful.

Suggested Teaching Strategy:

Explain that a logical next step for applying biomimicry to a design challenge is to translate the design question/challenge into biologic terms.

Tell students this translation is sometimes called "biologizing" the design question. The goal is to turn a "How might we…" design question into one or more "How does nature..." research questions. What we are doing is taking the human need or function expressed within the design question and rephrasing it so that an answer can more easily be found in biology.

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Getty Images 103124060: Steve West: Woman's hand touching wild flowers in meadow

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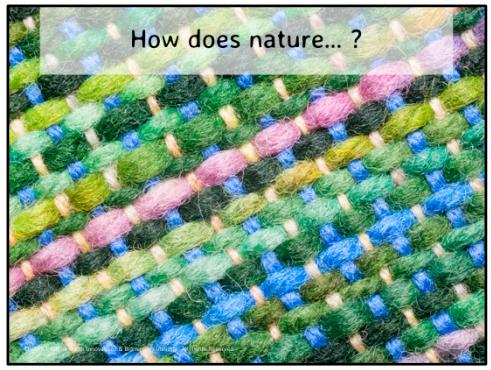

Objective:

- Describe how to translate design problems into biology research questions and why that process is helpful.

Suggested Teaching Strategy:

As an example, share with students: It sounds pretty silly to ask nature "How might we reduce the use of toxic dyes in textile manufacturing." Right? Nature doesn't make textiles or dye things! It would be hard to research this question. A much better question would be to ask: "How does nature create color?" This simplified question expresses the essence of what the design challenge is: creating color (on fabric). Researching this question could lead you to nature's non-toxic strategies for creating color, which could potentially be emulated for coloring fabrics.

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Getty Images 466379130: James Brey: Colorful Wool Woven Fabric Closeup, Macro

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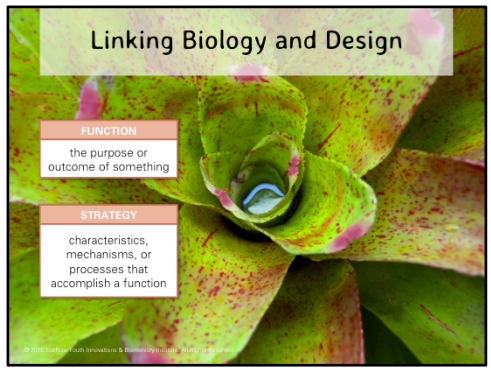

Objective:

- Describe how function and strategy link design and biology.

Suggested Teaching Strategy:

Tell students there are two concepts that help us make this link between biology and human design. They are function and strategy.

- A function is the purpose or outcome of something. It is usually expressed as a verb (e.g., to collect water, to produce color, to insulate, etc.).
- Strategies are characteristics, mechanisms, or processes that accomplish a function.

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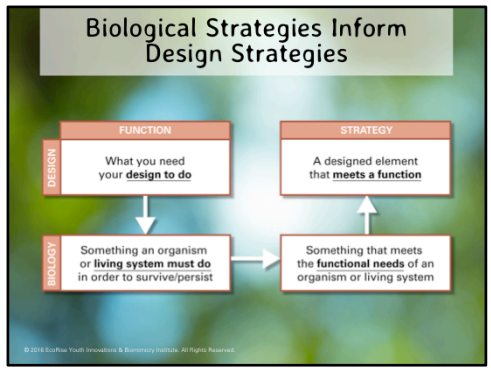

Objective:

- Describe how function and strategy link design and biology.

Suggested Teaching Strategy:

Point out that we can find functions and strategies both in nature and in human designs. In the context of biomimicry, function refers to the role played by an organism's adaptations or behaviors (its strategies) that enable it to survive. Importantly, function can also refer to something you need your design solution to do. We look for matches between functions in design and in nature in order to find **biological strategies** for that function, which can then inform **design strategies** to solve similar human challenges.

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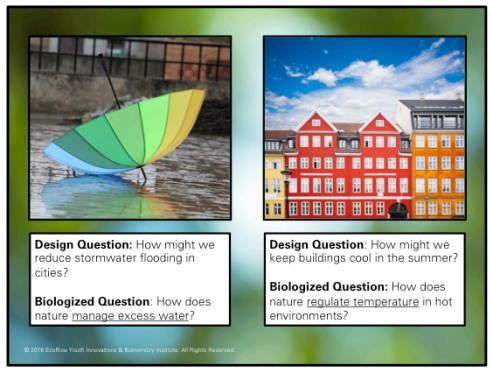

Objective:

- Demonstrate how to identify biologically relevant functions and contexts within a design challege.

Suggested Teaching Strategy:

Share with students a couple of additional examples. Ask: Do you see how the underlined function in the biologized question relates to the design question?

Often, the design question already contains function information (either explicitly or implicitly). You may simply need to change how you state the function(s) and context(s), choosing different words so that "asking" nature makes sense.

- Flooding is a consequence of excess water, so reducing or managing excess water is the function.
- Keeping cool is a matter of reducing/maintaining or "regulating" temperature.

NOTE: "Managing" and "regulating" are key words that can be very helpful when describing functions, because they are somewhat open-ended.

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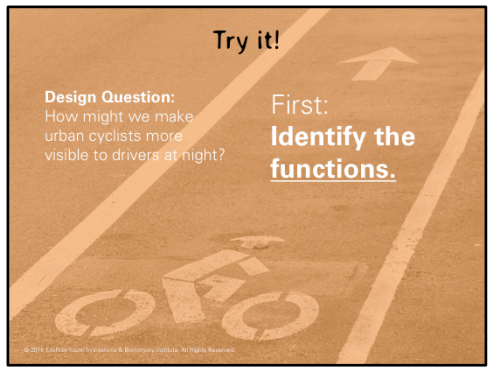

Objective:

- Demonstrate how to identify biologically relevant functions and contexts within a design challege.

Suggested Teaching Strategy:

Tell students: Let's do one together now. The first step is to think about the functions related to this challenge and how they can be expressed in bio-friendly terms. Ask a student to read the design question out loud. Then ask: What basic functions (that you could ask nature) can you derive from this question? You may want to write their answers on the board. *Sample answers:*

- *Improve/enhance visibility (the words "more visible" are right there in the question!).*
- *Produce light or reflect light (it's dark at night and humans need light to see, so these functions could be useful).*
- *Sense/send signals (e.g., opens the possibility for other nonvisual ways to make drivers aware of cyclists).*

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Objective:

- Demonstrate how to identify biologically relevant functions and contexts within a design challege.

Suggested Teaching Strategy:

Next have students consider the context of the design question. Ask: What are the conditions we need to design for that could affect how we might accomplish the functions we identified? Write their answers on the board.

Sample answers:

- *Dark/low light (Unless we're designing for the Arctic Circle in summer, it's going to be dark at night.)*
- *Chaotic/busy environment (We know the setting is urban—usually this means busy streets.)*
- *Moving quickly (Cyclists and cars are on the move, so the design needs to work for moving objects.)*

Tell students: Context is important to consider because strategies vary depending on the context. What works in one context may not work in another. Emphasize the following points:

- Context in biology encompasses the surrounding environment and all other factors affecting the survival of an organism.
- Context in design encompasses factors affecting how and where the design is used, and by whom. These, in turn, may define the criteria and constraints a design solution must account for.

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Objective:

- Demonstrate how to identify biologically relevant functions and contexts within a design challege.

Suggested Teaching Strategy:

Now lead students to put all of these ideas together into a "How does nature…" question. Call for volunteers to give it a try. There are multiple correct answers, so you may want to list several on the board.

Sample answers: How does nature…

- *…enhance visibility in low-light environments?*
- *…enhance visibility in chaotic environments?*
- *…sense movement in the dark?*

Explain that with a design problem there are often multiple functions at play and multiple ways to define function and context biologically. That's OK! Framing your function in multiple ways enhances innovation because it gives you more search terms to work with in the research phase. Tell students that their teams will be using this process (identifying function and context within their design question and stating them biologically) to complete their homework and arrive at one or more "How does nature…" questions for their Challenge project.

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