 

**ELEMENTARY SCHOOL**

**Sustainable Science**

**Properties of Adhesives:**

**A Sticky Situation**

**Lesson 1: What Do We Learn from Animals?**

**Teacher Background and Overview:**

Biomimicry is the science and art of emulating nature’s best biological ideas to solve human problems. Chemists and materials scientists often use biomimicry to get ideas for their work as the natural world is made up of excellent green chemists. If we consider how animals make their own shelter and get all the food they need, we see that they do this without having to use any gas or electricity, or taking more than they need, while only producing waste that can be used by other living things. Green chemistry principles provide scientists with the criteria to design safer, more cost effective, and better performing materials. When scientists look to nature for inspiration, they find sustainable ideas from unique places to help them make better technologies.

This lesson introduces students to biomimicry, first by decoding and defining the word, then by an interactive matching game that challenges students to think like scientists and engineers in considering different aspects of the natural world.

**Additional Resources:**

<https://asknature.org/>

<https://biomimicry.org/biomimicry-examples/>

<https://inhabitat.com/design/biomimicry/page/4/>

**Time Required:**

30 Minutes

**Learning Objectives:** Students will…

* Use word analysis skills to decode words.
* Explain how scientists derive inspiration from nature for technological innovation.

**Standards:**

***NGSS***

**5-ESS3-1**Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.

***Massachusetts Standards***

*STE*

**5.3-5-ETS3-1(MA)** Use informational text to provide examples of improvements to existing technologies (innovations) and the development of new technologies (inventions). Recognize that technology is any modification of the natural or designed world done to fulfill human needs or wants.

*ELA & Literacy*

**RSIT.5.3** Explain the relationships or interactions of two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

**RSFS.5.3** Know and apply grade-level phonics and word analysis skills in decoding words.

**SL.5.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others’ ideas and expressing their own clearly.

**Materials:**

* Intro Biomimicry Matching Game cards (one per team of 4), available at <http://www.beyondbenign.org/lessons/intro-biomimicry-matching-game/>

**Teacher Preparation:**

* Print and cut Biomimicry Matching Game cards.

**Keys to Success:**

* Biomimicry is about inspiration! As students share their answers, it is important to affirm their creative thinking. If their rationale for a match does not agree with the answer guide but demonstrates that the team thought critically, remind the students that biomimicry is about ideas, so though they may not have the same answer as you, it does not mean that they are wrong.
* After the lesson, you may wish to post the cards around the room to help students connect the following lessons to biomimicry.
* If you prefer to run the matching game as a class rather than in teams, you can create a display with the technology cards on the right and the nature cards on the left. Have the students connect the technology card with the correct animal card.
* Instead of printing cards, you could create an interactive whiteboard presentation that would allow the students to manipulate the images to match.

**Extensions:**

* Share other examples that may demonstrate biomimicry. The links in Additional Resources are a great place to start.

**Procedure:**

1. Introduce the term *biomimicry*.
2. Have students break down the word by defining “bio” and “mimic.” Define the term together as a class. If needed, provide an opportunity for students to look up the definitions of “bio” and “mimic.”
3. Explain to the class that biomimicry is the science and art of getting inspiration from nature for the design of technologies.

* Biomimicry provides *ideas* for innovations and inventions and the *design* of those products comes from chemistry and engineering.
* Green chemistry is the science of designing safer products and processes. Biomimicry often provides new ideas to green chemists because of the ways that nature makes amazing materials and performs complex chemical processes in conditions that are not harmful to the environment, while creating very little waste.
* For a new technology to be considered green chemistry, it must meet three criteria when compared to existing technologies: it must be safer for human health and the environment, it must cost the same or less, and it must work just as well or better.
* Biomimicry helps green chemists make new products for every area of life that meets these criteria.

1. Hand out sets of the Biomimicry Matching Game cards.
2. Instruct the teams to match the technology/product card to the animal/plant card. Explain that they will need to be prepared to explain why they put each pair together. They may want to think about the following questions when considering their matches:

* Was it the form?
* Was it the function?
* How was the technology improved, based on the natural organism?

1. Give teams 5–10 minutes to brainstorm and match the cards.
2. Bring the class back together. Ask teams to share their matches with the class and explain their choices. Remind the class that biomimicry is about inspiration. If a team did not get the same match as the answer guide, it does not mean that they were wrong, rather that they were inspired differently.
3. Briefly review and clarify any questions using the answer guide.

**Wrap-Up/Assessment:**

1. Consider using one of the following options for assessment:

* Journal Reflection: To get students thinking about adhesives for the upcoming lessons, have them name an animal that uses a natural glue and for what purpose. Have them journal about how this may help the animal survive and, if time allows, illustrate a picture of their animal choice.
* Exit Ticket: As the students leave the classroom, provide the animal cards and have each student match an animal with the appropriate technology card. If you have students who are likely to struggle, guide them to the end of the line so there will be fewer choices.

**Biomimicry Matching Game Answers**

|  |  |
| --- | --- |
| Kangaroo | Landfill |
| Blue Mussel | Toxin-free, waterproof glue |
| Termite | Electricity-free air conditioning for buildings |
| Gecko | Bandages |
| Chimpanzee | New sources of natural medicines |
| Shark | Faster boats and submarines |
| Blue Morpho Butterfly | Toxin-free paints |

Kangaroos have special bacteria in their stomachs that neutralize the digestive process of gases so they don’t release methane gas. Methane is a greenhouse gas and is linked to global climate change. Landfills and several manufacturing processes release methane gas. The bacteria in kangaroos could hold the key to transforming methane-producing systems to release a more benign gas.

Blue mussels live in the water and have to stick to the sides of rocks and hold on through stormy waves. The blue mussels are able to cling to rocks, thanks to their unique adhesive chemistry. Because of inspiration from blue mussels’ adhesive properties, advances in the glue used in plywood have already occurred and the hope is to create alternative waterproof adhesives that do not contain any harmful chemicals (which are in a lot of glues used today).

Termites build their homes in a way that allows the space to stay cool all the time, even in really hot weather, without any air conditioning. Architects are copying the way termites build their homes to make buildings that stay cool in very hot weather without any air conditioning.

Geckos are very good climbers with special bristles (nanopillars) on their feet that allow them to walk on almost any surface, even upside-down, without falling. Even though their feet can hold onto any surface, they are not sticky and don’t leave any sticky residue behind. Scientists at MIT invented a bandage with glue consisting of thousands of nanopillars like the gecko. This innovation will replace sutures both inside and outside the body.

Chimpanzees are very similar to humans. They get injured and sick just like we do, but they don’t have any hospitals or medicine. Instead, they get better and stay healthy just by using things in their habitat. Doctors want to find out what the chimps eat to stay healthy and cure illnesses so they can make natural medicines by identifying and emulating the process in the lab.

Sharks are very good swimmers, being both fast and efficient. Engineers developed faster submarines using lessons learned from the hydrodynamic factors that allow sharks to swim fast. One of these factors is their special scales, called denticles, that reduce the amount of turbulence in the water and allow them to swim faster while using less energy.

Similar to many things in nature, blue morpho butterflies are very colorful. The pigments for our paints and dyes often contain hazardous materials. Scientists are learning how to use structural color, like that of the morpho butterfly, to make safer paints and fabrics.