

**ELEMENTARY SCHOOL**

**Sustainable Science**

**The Secrets of Sharks’ Skin**

**Teacher Background and Overview:**

Green chemistry is the science that provides tools at the beginning stages of design to create safer products. Biomimicry is a tool that green chemists use as they create materials that benefit both human health and the environment. This unit brings together biomimicry and green chemistry principles and concepts as students learn about Sharklet film, an antimicrobial film inspired by sharks’ teeth-like scales, called dermal denticles. Sharklet prevents the growth of bacteria simply by its physical structure at the micro-scale, as bacteria are unable to stick to its ridged, diamond-patterned surface. Because of its micro-texture, Sharklet film can be used on a variety of surfaces to stop problem bacteria from accumulating—without the use of chemical or antibiotic controls that encourage bacterial resistance. Sharklet Technologies is now a part of Peaceful Union, where they are accelerating the development of medical devices that incorporate the micro-texture.

In this unit, students are introduced to biomimicry and green chemistry as they learn about sharks and technologies that have been inspired by them. Then, students explore geometry while considering the micro-texture of Sharklet film. Finally, students investigate how Sharklet film prevents bacterial growth through a hands-on simulation.

**Additional Resources:**

*Sharklet Technologies* <https://www.sharklet.com/>

**Lesson Summaries:**

*Lesson 1*

Time Required: 30 minutes

This lesson sets the stage for talking about both sharks and biomimicry by introducing fun shark facts through a grammar-correcting challenge, then by considering examples of technologies modeled after sharks’ dermal denticles. In the upcoming lessons, dermal denticles will be discussed as the inspiration for Sharklet film, a micro-texture that prevents the growth of bacteria without the use of chemical or antibiotic methods.

*Lesson 2*

Time Required: 30 minutes

In this lesson, students are introduced to the patterns and shapes found in Sharklet film. Then students are asked to apply their understanding of geometry by drawing pictures of both the natural and man-made world, and labeling lines, angles, and shapes.

*Lesson 3*

Time Required: 30 minutes

In this lesson, students will begin to explore how Sharklet film works to prevent the growth of bacteria. They will be considering two major properties of the micro-texture: the shape of the pattern and the size of the pattern. Each student will be free to choose which shape they would like to make for their simulated Sharklet pattern. Then, they will make a one-inch, two-inch, and three-inch model of this pattern. In the upcoming lessons, students will test the ability of their patterns to prevent sticking and evaluate their data as a class to determine how the Sharklet film works.

*Lesson 4*

Time Required: 45 minutes

In this lesson, students will evaluate the puffy-paint Sharklet surface models they made in Lesson 3. Students will use sticky notes and binder clips to simulate the accumulation of bacteria on both the Sharklet surface and a flat surface. As students compare their three models, they will collect data to compare with the rest of the class in Lesson 5. Ultimately, students will find that the shapes they used to make their Sharklet model are less important than the spacing of the puffy-paint dots within their pattern. They will also find that it is much more difficult for the sticky note to hold onto the models than to the flat surface.

*Lesson 5*

Time Required: 30 minutes

In this lesson, the class will compare the Lesson 3 data from each team. After discussing the results as a class, the students should conclude that the size of their Sharklet pattern and the spacing of their puffy paint matters more than the shape of their pattern. This leads to a discussion of how the Sharklet film works to prevent the growth of bacteria. The lesson and the unit wrap up by considering how the pattern of shark denticles benefits sharks’ survival.

**Standards:**

***NGSS***

**4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. *Lesson 1, Lesson 5*

**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. *Lesson 3, Lesson 4*

**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. *Lesson 3, Lesson 5*

**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.*Lesson 4*

***Massachusetts Standards***

*STE*

**4-LS1-1** Construct an argument that animals and plants have internal and external structures that support their survival, growth, behavior, and reproduction. *Lesson 1, Lesson 5*

**4.3-5-ETS1-3** Plan and carry out tests of one or more design features of a given model or

prototype in which variables are controlled and failure points are considered to identify which features need to be improved. Apply the results of tests to redesign a model or prototype. *Lesson 3, Lesson 4*

**4.3-5-ETS1-5(MA)** Evaluate relevant design features that must be considered in building a

model or prototype of a solution to a given design problem. *Lesson 4, Lesson 5*

*ELA & Literacy*

**RSIT.4.2** Determine the main idea of a text and explain how it is supported by key details; summarize the text. *Lesson 1, Lesson 4*

**RSIT.4.7** Interpret information presented visually, orally, or quantitatively (e.g., charts, graphs, diagrams, time lines, animations, or interactive elements on web pages) and explain how the information contributes to an understanding of the text in which it appears.*Lesson 5*

**RSFS.4.3** Know and apply grade-level phonics and word analysis skills in decoding words. *Lesson 1*

**RSFS.4.4** Read with sufficient accuracy and fluency to support comprehension. *Lesson 1*

1. Read grade-level text with purpose and understanding.

**SL.4.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others’ ideas and expressing their own clearly. *Lesson 1, Lesson 2, Lesson 3, Lesson 5*

**LS.4.1** Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.*Lesson 1*

**d:** Order adjectives within sentences according to conventional patterns (e.g., *a small red bag* rather than *a red small bag*).

**f:** Produce complete sentences, recognizing and correcting inappropriate fragments and run-ons.

**g:** Correctly use frequently confused words (e.g., *to, too, two; there, their, they’re*).

**h:** Write legibly by hand, using either printing or cursive handwriting.

**LS.4.2** Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. *Lesson 1*

**a:** Use correct capitalization.

*Math*

4.MD.4 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement qualities using diagrams such as number line diagrams that feature a measurement scale. *Lesson 4*

4.G.1 Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. *Lesson 2*

**4.G.2** Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles. *Lesson 2*

**4.G.3** Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry. *Lesson 2*