NCTA Lesson Plan

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Title: Unfolding the Secrets of DNA Origami

Theme/Topic: DNA Protein Folding

Introduction: In this lesson students will be briefly introduced to the history of origami by examining (and possibly creating) examples of origami sculptures. The students will then explore how the art of origami can be used to explain various DNA folding patterns as well as biomedical applications utilizing DNA origami.

Subject(s)/Grade level(s): 8th Grade Science

Duration of lesson: Two 43-minute class periods

Connection to Next Generation Science Standards:
MS-LS3-1 -In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Science and Engineering Practice: Obtaining, evaluating, and communicating information - Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).

Cross Cutting Concept: Structure and function - The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Essential Questions:

What is origami?
What enables DNA to fold on its own?
How has DNA origami impacted the medical field?

Learning Objectives:
Students will be able to

Explain the similarities and differences between paper origami and DNA origami.
Explain the chemical processes by which DNA is able to fold.
Describe the medical applications of DNA origami.

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Materials Needed:
Examples of origami (videos, pictures, or other samples)
Chromebooks (one per student or pair of students)
3D DNA model (helpful but not required)
Articles about DNA origami (These may be preselected or the students can search for them independently)

Pre-Assessment of Prior Knowledge: ***How will students show what they already know about the topic of this unit? What activities will be used?***
Class will begin with students completing a brief online quiz to review their understanding of the basic structure and function of DNA. Once the students have finished the quiz, they will be asked to review photographs/videos/hands-on examples of origami and write a journal prompt about what they know about origami.

Lesson Activities/Instructional Strategies (5-7 steps):
The teacher will begin by reviewing the answers to the DNA quiz questions and leading a brief review discussion of DNA and its role in genetics.

The teacher will then ask the students to share their journal prompts. As the students share, the teacher will lead the class in a brief discussion of origami, emphasizing its origin, importance, and impact. The teacher should also remind the students that each fold is important and contributes to the overall structure of the design.

While still in small groups, the teacher will ask the students to think about the possible similarities between DNA and origami. After providing time for students to discuss, the teacher will lead a whole class discussion on the similarities and differences. Once the idea of folding is brought up, the teacher will steer the discussion to focus on the importance of folding patterns in origami and explain how folding takes place in DNA strands (based on chemical bonding).

The teacher will explain that DNA origami has become very helpful in the medical field and can be used for a variety of purposes. The teacher will then review definitions and examples of DNA origami using online resources.

Next, the teacher will explain that the students will be working in small groups to explore some of the medical uses of DNA origami and share their findings with the rest of the class. Students may conduct their own research or the teacher may provide pre-selected websites. A list of examples can be found in the resources section.

After conducting research, students will share their findings with the rest of the class in the form of a brief presentation. As a concluding assignment, students will individually write about the similarities and differences between paper origami and DNA origami as well as explaining how aspects of culture can be used as inspiration for scientific research and discovery.

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Resources:
Between the Folds: History of Origami - PBS website
Free Origami Instructions
What is DNA Origami

Websites containing DNA origami examples:
DNA Origami Heals Kidneys
DNA Origami Helps with Cancer Therapeutics
How DNA Origami Creates Super Materials

Closing/Reflection Activity: ***How are students engaging with ideas from another culture? What does it mean for them?***
Students learn about the history of origami in Japan. Additionally, they learn about the similarities between paper origami and DNA origami. Finally, the students learn about the DNA origami research that has been conducted by labs around the world. Learning about the facets of origami can help students understand that culture and cultural ideas can serve as a creative basis for scientific ideas and discoveries.

Post-Assessment: ***How will students demonstrate what they have learned about the topic from this unit? What activities will be used?***
Students will demonstrate their understanding of the topic by writing a summary explaining how the ideas and concepts of paper origami have led to developments in DNA origami.

Extension Activities/Extending the Lesson/Cross-Curricular Connections:

Students could create their own origami designs or use a website to follow the instructions to create designs. As students create designs, mistakes or misfolds could be compared to mutations, which can impact the structure and function of DNA.

Students could create origami designs as an art extension.

Students could read more about origami or view the movie Between the Folds to develop a deeper understanding of origami.