Name: Brittany Anderson
Lesson Title: Dog DNA
SSI Topic: Pompe Predicament
Lesson Length (class periods): 1
Grade Level(s): 7

Appropriateness for Middle/High School Students
Describes the teaching strategies used in this lesson that address the needs and interests of your students and how they build a cohesive science/mathematics experience for students.

This lesson uses the 5E learning format. Students will use collaboration to explore patterns of inheritance using fictional dogs as a model.

Background
Provides a description (150-250 words) of the SSI-based science concepts covered in this lesson.

DNA holds the letters that code for almost all life on Earth. During transcription and translation, DNA is read and translated into proteins that determine the phenotype of an organism. As DNA replicates, mistakes or mutations can take place. Some negative mutations can result in severe genetic diseases (ex: Pompe disease). DNA information (including mutations) can be passed along from one generation to the next. The body’s process of transcribing and translating a DNA sequence into a protein can be an abstract process, in which students may have a difficult time visualizing. Students can use this activity to practice the process of transcribing a sequence of DNA using complimentary base-pairing rules and to observe inheritance patterns.

Florida State Standards (NGSSS)
List the Florida Sunshine State Standards (SSS) that directly applies to your objectives, as well as the NGSSS for relevant grade level(s) that you will connect the lesson content to.

Grade Level NGSSS:
S.C.7.L.16.1 Understand and explain that every organism requires a set of instructions that specifies its traits, that this hereditary information (DNA) contains genes located in the chromosomes of each cell, and that heredity is the passage of these instructions from one generation to another.

Preceding Grade Level NGSSS:
S.C.6.L.14.3 Investigate and explain the components of the scientific theory of cells (cell theory): all organisms are composed of cells (single-celled or multi-cellular), all cells come from pre-existing cells, and cells are the basic unit of life.

S.C.6.L.14.3 Identify and investigate the general functions of the major systems of the human body (digestive, respiratory, circulatory, reproductive, excretory, immune, nervous, and musculoskeletal) and describe ways these systems interact with each other to maintain homeostasis.

Subsequent Grade Level NGSSS:
S.C.912.L.16.2 na (H) Discuss observed inheritance patterns caused by various modes of inheritance, including dominant, recessive, codominant, sex-linked, polygenic, and multiple alleles.

Performance Objectives
- State two or three objectives that relate to the science
and/or mathematics concept(s) and state benchmarks for your lesson.

Students will be able to..
1.) Discuss observed inheritance patterns
2.) Describe the basic process of DNA replication and transmission of genetic information
3.) Explain how gene mutations may or may not result in phenotypic change

Materials List and Student Handouts
- List the materials, equipment, and supplies needed for the lesson.
- Include the quantities required per group and/or per student.

**One set of materials for each pair of students
1.) Science Take-Out From DNA to Protein Structure handout (modified; Only includes steps from DNA → mRNA → amino acid sequence
2.) Base-pairing chart
3.) Genetic code chart (key; assigns each mRNA codon an amino acid)
4.) Dog trait key (Assigns groupings of amino acids a phenotype to display as an illustration ex: Met-Phe-Leu= Wired hair ex: Met-Phe-Leu=Long, shaggy hair)
5.) White construction paper
6.) Colored pencils

5E Lesson Template

In the left column, list all activities you are planning. Also include information on how the class will be organized (grouping; individual work). The right column contains only probing questions you intend to ask of your students to guide their learning. For each phase, complete a brief (2-3 sentence) overview of what will occur in the space provided.

Consider the following during the Engage:
- Include an interesting attention grabber that focuses students' interest and attention on the lesson content and activities.
- Introduce a guiding question that students should be able to answer at the end of the lesson.

Probing Questions:
- Elicit prior knowledge and students' experiences.

<table>
<thead>
<tr>
<th>ENGAGE</th>
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<tbody>
<tr>
<td><strong>Overview</strong></td>
</tr>
<tr>
<td>Students are introduced to glycogen storage disease and the studies done at UF with the maltese dogs involving gene therapy. We will focus on how the dogs get the disease.</td>
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Teacher presents and illicit student background knowledge on body sugar (levels, diabetes, nutrition, etc) DNA and genes.

Teacher will lead discussion and present brief powerpoint about glycogen storage disease and gene therapy performed on the dogs.

What happens when your body has too much sugar? Too little? Why is it important for your body to maintain certain sugar levels?

What set of instructions does our body follow to determine what traits we have?

### Consider the following during the Explore:
- Explain how your students will explore the concept(s), relating specifically to SSI-LPAI elements when appropriate, including students’ interests shared during the Engage.

### Probing Questions:
- Design questions that guide student explorations, evaluate student understanding, and facilitate student interaction and group collaboration.

### EXPLORE

**Overview**
Students will transcribe and translate a sequence of dog DNA using the base pairing chart and genetic code chart.

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<tr>
<td>Ex: ATA GGC AGC TTA TTG CAT GAT TGA GAA</td>
<td>How does changing the amino acid sequence affect the protein?</td>
</tr>
<tr>
<td>students will use the base pairing chart to determine the base sequence code on the mRNA that would be produced when the DNA molecule is transcribed to make mRNA. The first mRNA bases will be provided as samples. The mRNA base sequence and the genetic code chart will be used to translate the mRNA code into a sequence of amino acid building blocks in a protein. The amino acids will be identified using the genetic code chart.</td>
<td>How does this determine which trait (phenotype) the dog will have?</td>
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</table>

### Consider the following during the Explain:
• Have students share and explain the results of their investigation. Connect to relevant SSI-LPAI elements.
• Add additional content, including definitions, explanations, and new vocabulary in the context of concepts explored.

**Probing Questions:**
• Ask probing questions to deepen students’ conceptual understanding and skills of the concepts that the lesson is based upon.

### EXPLAIN

**Overview**

Students will utilize a dog trait key to explain and illustrate the traits of their dog.

**Vocabulary:** DNA, genotype, phenotype, inherit/inherited/inheritance

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<td>Using construction/poster paper and colored pencils, students will use the dog trait key to illustrate the traits of their dog (basically they draw the dog). Students must include a 150-200 word write-up that uses the above highlighted vocabulary to address the probing questions.</td>
<td>Why does your dog look the way it does? What determines the DNA sequences the dog has? Why does each dog look different?</td>
</tr>
</tbody>
</table>

**Consider the following during the Elaborate:**
• Opportunity to provide students with the chance to transfer and extend (apply) the concepts and skills they have just learned to their interests and new situations.

**Probing Questions:**
• Connect and apply the lesson to students’ interests outside the classroom.

### ELABORATE

**Overview**

Teacher will explain what occasionally happens as DNA is transcribed---- a mutation (can be deletion, insertion, nonsense, or missense). Mutations may or may not result in phenotypic change. When this mutation is passed from parent to offspring, they can inherit a genetic disease, such as Pompe disease. Students will transcribe and translate the GAA gene to determine and illustrate whether or not their dog has the disease. GAA is a protein molecule found in lysosomes responsible for processing excess glycogen being stored into smaller components of glucose.

**Vocabulary:** mutation, Pompe disease, transcription, translation

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As directed by the teacher, students will focus on the GAA gene. The “normal” sequence will be revealed, and students will analyze their dog’s DNA to determine if it has a mutation that results in Pompe disease. They will need to illustrate whether or not their dogs have Pompe disease (glycogen storage disease) by highlighting the dog’s liver PURPLE.

Students must add to the 150-200 word write-up that uses the above highlighted vocabulary to address the probing questions.

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<tr>
<td>What happens when one of the bases are mutated?</td>
<td></td>
</tr>
<tr>
<td>How does this affect your dog?</td>
<td></td>
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</tbody>
</table>

Consider the following during the Evaluate:
- Utilize the grading rubric you designed for the formative assessment tool (during session 4) to assess the students’ mastery of all benchmarks.

**EVALUATE**

**Overview**
Ten-Two is a reflection strategy that will be used after the presentation of glycogen storage disease to reflect on and summarize what they have learned thus far.

Sequencing will be used on a whiteboard using sticky notes to examine students’ ideas about the sequence of events that would occur as a result of a gene mutation in the gene that codes for the protein GAA. In Pompe disease, one amino acid in the GAA protein is incorrect. This formative assessment will serve as formal content development and transfer and a reflection.
**After the powerpoint:** After the ten-minute “engage” presentation, students are given two minutes of time to quietly think, summarize, and jot down key points of what they learned so far.

**After the lesson:** Students, working in pairs, are provided 7 sticky notes to write and sequence the events that lead to Pompe disease.

- ___ Gene mutation (change in the DNA code in the gene for GAA)
- ___ Change in the mRNA code
- ___ Change in the amino acid sequence of the GAA protein
- ___ Change in the structure or function of body cells or tissues
- ___ Change in the ability of the GAA protein to function properly
- ___ Change in characteristics and symptoms of a genetic disease

**Sequencing Evaluation Scoring Rubric**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
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<tbody>
<tr>
<td>4</td>
<td>Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct. ALL CARDS IN THE CORRECT SEQUENCE. 1,2,3,5,4,6</td>
</tr>
<tr>
<td>3</td>
<td>Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct. TWO CARDS ARE IN THE INCORRECT POSITION IN SEQUENCE. ONE SWAP WILL PLACE ALL CARDS IN THE CORRECT SEQUENCE.</td>
</tr>
<tr>
<td>2</td>
<td>Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct. THREE CARDS ARE IN THE INCORRECT POSITION IN SEQUENCE.</td>
</tr>
<tr>
<td>1</td>
<td>Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimally present or correct. MORE THAN THREE CARDS ARE IN THE INCORRECT POSITION IN SEQUENCE. HOWEVER, THERE IS MINIMAL EVIDENCE OF UNDERSTANDING PRESENT (EX: 2 OR THREE CARDS MAY BE IN SEQUENCE, i.e. 1st and 2nd or 5th and 6th)</td>
</tr>
<tr>
<td>0</td>
<td>All descriptions of scientific terms, facts, concepts, principles, theories and methods are missing and/or incorrect.</td>
</tr>
</tbody>
</table>

What can you summarize about glycogen storage disease (Pompe disease)?

What causes a mutation?

How can you think of this event as a domino effect?