University at Buffalo
Genome, Environment and Microbiome
Community of Excellence

STAGE 1 – DESIRED RESULTS

Lesson Title: Gel Electrophoresis Simulation

Grade: high school

Time: 30 minutes

Overview: This simulation provides a hands-on, active learning experience that allows students to grasp how DNA is separated by size during gel electrophoresis.

Learning Goals/Understandings:

Life Science Next Generation Science Standards (NGSS)

Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

Essential Questions:

- How does gel electrophoresis separate DNA based on size?

Students will know:	Students will be able to:
• Gel electrophoresis separates DNA molecules based on size (the longer the DNA fragment, the longer it takes to migrate through the gel and the shorter the distance it will travel)	• Simulate DNA migration through a gel with beads on a string, Styrofoam, and toothpicks • Explain the relationship between fragment size and migration rate and distance traveled in a gel

STAGE 2 – ASSESSMENT EVIDENCE

Students' understanding will be assessed based on observation of their participation during the simulation and answers to questions.

STAGE 3 – LEARNING PLAN

Summary of Learning Activities:

1) Have Styrofoam sheet and beads on a string already prepared.

- Place toothpicks in Styrofoam sheet to create a lattice. Place beads on a string, tying them, to simulate histone proteins and DNA.

- Try 4 beads on a string and 10 beads on a string. (The actual numbers of beads on the string do not matter. Just make sure that the length is different enough so that students can detect a difference during the demonstration.)

2) Ask students which beads on a string (short or long) they think will get from one end of the Styrofoam sheet to the other the fastest. Have students explain their answers (The shorter fragment will be easier to navigate through all of the toothpicks, so it will reach the other end the fastest).

3) Have a volunteer demonstrate, pulling the DNA beads on a string, through the spaces between the toothpicks on the Styrofoam. Have the student then try doing the same thing with the longer strand for comparison. The difficulty with the longer strand should be visible, but the student can still be asked to discuss the differences.

4) Now, vary the number of toothpicks on the Styrofoam board. Discuss with students how the number of toothpicks or how close together they are influences the rate at which the beads on a string go through. (The greater the number of toothpicks and the closer they are together, the harder it will be for the beads on a string to migrate through, which will delay the migration rate).

**If possible, have each student or groups of students experiment with the different numbers of beads on a string and number and placement of toothpicks. Just model for students to get them started and circulate and assist.

5) Discuss with students their findings.

- The greater the number of beads, the harder it was for it to get through.
- The more the toothpicks, the closer they were together, and smaller space between the toothpicks, the harder it was to get through as well.

6) Connect this example with gel electrophoresis and DNA. Explain the comparisons with students (The Styrofoam represents the agarose gel, and the spaces between the toothpicks represent the pores in the gel. The beads on a string represent the DNA and histone proteins, and the different number of beads represent the differently sized fragments).

**An extension or an alternative could be for students to do the same thing on a larger scale, in a form of an obstacle course. The classroom could be converted into an obstacle course with desks, tables, garbage cans, etc., while students try to navigate through (first with one person and then with more individuals holding hands). Emphasize safety precautions with this procedure.

Materials:

- Flat Styrofoam squares (size: about 6” by 4”)
- String
- Beads, approximately ½” in diamater
- Toothpicks