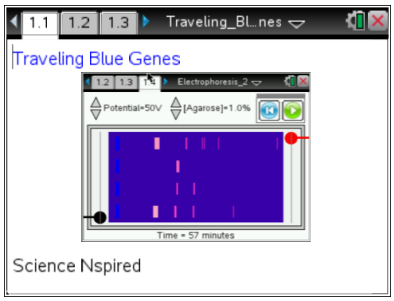
Traveling Blue Genes

SCIENCE NSPIRED

Science Objectives

- Students will observe a time-lapse simulation of the process of DNA Gel Electrophoresis.
- Students will electronically measure the results of gel electrophoresis and then graph, and analyze these results.
- Students will discover the effects of time, voltage, and agarose gel density on the results of gel electrophoresis.



Vocabulary

- adenine
- thymine
- guanine
- cytosine
- agarose
- base pair
- NA gel electrophoresis
- double helix
- interpolation
- extrapolation
- nucleotide
- phosphate
- deoxyribose
- restriction enzymes

About the Lesson

- This lesson involves students using TI-Nspire technology to simulate, observe, and manipulate the variables that affect the results of DNA gel electrophoresis.
- As a result, students will:
  - Reinforce understanding of the structure of DNA;
  - Understand the process of gel electrophoresis;
  - Recognize the effects of time, gel density, and voltage on the outcome of gel electrophoresis.

TI-Nspire™ Navigator™

- Send out the *Traveling_Blue_Genes.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Traveling_Blue_Genes _Student.doc
- Traveling_Blue_Genes _Student.pdf

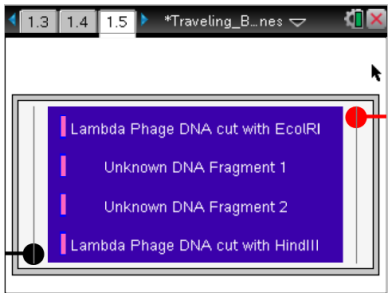
TI-Nspire document

- Traveling_Blue_Genes.tns

Discussion Points and Possible Answers

Have students read the background information on their student activity sheet.

Move to pages 1.2 - 1.5.

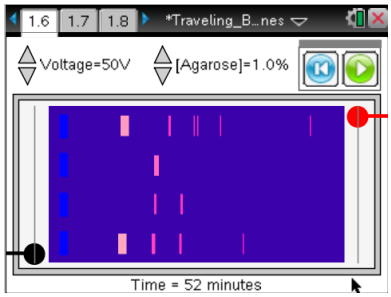


1. Have students read the directions for running and measuring the bands on a gel. The restriction enzymes EcoRI (pronounced 'eco R 1', which is short for *E. coli* restriction enzyme 1) and HindII ('hin D 3,' which comes from *H. influenza*) were first used to "cut" up some viral DNA. (Phage are viruses that infect bacteria). Bacteria cause these enzymes to defend against foreign DNA from viruses by cutting DNA with unique sequences. Then, this "cut up" DNA is placed into the wells next to two unknowns and an electrical current is applied.

Restriction enzymes are used to cut DNA into a size that can run through a gel. A full chromosome is millions of base pairs long and would be very difficult to assess by electrophoresis.

The unknowns are human samples being tested for some genotype. They are compared to Lambda phage DNA, a virus that infects E.coli (known as a phage), and they are cut into predictable band sizes which can be used as a control, or a *ladder*, for this type of experiment.

Move to page 1.6.



2. Students should follow the directions to run the simulation and measure the size of each band, which will be recorded to the spreadsheet on page 1.14.
3. The fragments—shown as the pink bands—migrate different distances based on their size. Smaller fragments move further because it is easier for them to get "pulled" through the gel toward the positive electrode (shown in red, at top right of gel).

Tech Tip: The cursor will change to a cross when you are in the correct spot to take the measurement of the band.

Tech Tip: To take a measurement of a band, tap the band as it moves across the screen.

Move to pages 1.7 - 1.13. Have students answer questions 1 - 7 below and/or in their .tns files.

Q1. The DNA moves

Answer: B. due to the charge on the molecule.

Q2. True or False: Increasing the voltage across the gel causes the DNA to migrate slower.

Answer: false

Q3. True or False: Increasing the agar concentration in the gel causes the DNA to migrate slower.

Answer: true

Q4. True or False: Reversing the voltage causes the DNA to migrate the opposite direction.

Answer: true

Q5. True or False: The longer the gel runs the further the DNA migrates.

Answer: true

Q6. If the gel runs too long, the DNA...

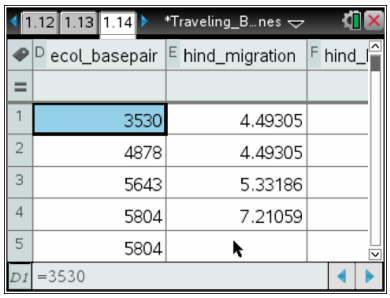
Answer: B. runs off the end of the gel

Q7. True or False: The purpose of a DNA ladder is to have a standard between migration and fragment size.

Answer: true

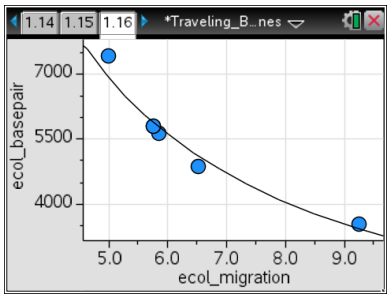
Move to page 1.14.

4. After measuring all the bands, the distances will appear in each labeled column, including the known sizes of the digested phage DNA.

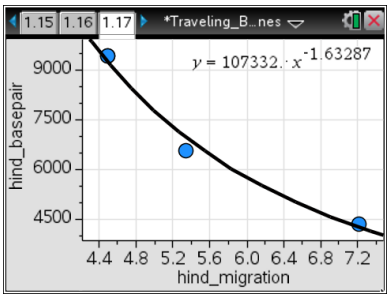


Move to pages 1.15 - 1.17.

4. Have students read the directions on page 1.1.5. When they move to pages 1.16 and 1.17, the students will see a graph of the distance vs. the size of DNA, measured in base pairs.
5. They should be encouraged to explore the best line of fit to describe these data. On each page, use **Window/Zoom > Zoom-Data** to scale the graph. Next, use **Analyze > Regression** and try different regression equations to find the best-fit. Lastly, use **Analyze > Graph Trace** to find the fragment size associated with the migration of the unknowns.



6. At this point, students are asked to sketch the graph on their activity sheet. You may also require them to draw in a non-linear best-fit model for the data. From this, you can ask students to predict how far other fragments would have moved. Use both interpolation and extrapolation for the other fragments. The line of best fit of the data should look similar to the graph above for EcoR1 band migration.



Move to pages 1.18 - 1.19. Open response questions 10 - 16 should be answered on the Student Activity worksheet.

Q8. Based on the graphical analysis of the data, the DNA fragment size of unknown 1 is approximately:

Answer: C. 10,000 bp

Q9. If the two unknowns are the same gene harvested from two different individuals...

Answer: B. unknown 1 is homozygous and unknown 2 is heterozygous.

Q10. What is a restriction enzyme?

Answer: A molecule that "cuts" DNA at specific "base sequences". Many species of bacteria produce restriction enzymes so that invading DNA, normally from viruses, can be "cut" and rendered harmless.

Q11. What is the relationship between DNA fragment size and migration distance?

Answer: The smaller the fragment size, the further it can move from the well, and the larger the fragment size, the shorter it can move from the well.

Q12. What is meant by a "base pair"?

Answer: It is a pair of nucleotides (either an adenine-thymine (A-T) pair or a cytosine-guanine (C-G) pair) that makes up one "rung" of the DNA double helix.

Q13. What is the relationship between the amount of time that a gel runs and the migration distance of the DNA fragments?

Answer: If the gel density and voltage remain constant, then the longer the time, the further the fragments move.

Q14. Describe the effect of gel density on the movement of DNA fragments through the gel.

Answer: The denser the gel is, the slower the DNA fragments move. The less dense, the faster they move.

Q15. If you want to run a DNA gel electrophoresis experiment with only a short time available, what general parameters would ensure the best results?

Answer: Less dense gel and a high voltage.

Q16. If you want to run a gel from the time you leave class until the start of class the next day, what general parameters would ensure the best results?

Answer: Dense gel and low voltage.

TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the parameters of time, gel density and voltage. Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

When students are finished with the activity, pull back the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show. Additionally, completed Student Activity sheets may be collected.

Assessment

- Analysis questions are written into the student worksheet.
- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.