

Gel Electrophoresis

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Date Created: December 2015

Subject: Biology

Grade Level: 7-12

Standards: Next Generation Science Standards (www.nextgenscience.org)

MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

Schedule: 30 minutes for pre-lab, 1-hour for the lab and 30 minutes for the analysis

CCMR Lending Library Connected Activities:
 Extracting DNA



<p><u>Objectives:</u> Students will learn how gel electrophoresis, works and its use in fields like forensics to study DNA of various individuals.</p>	<p><u>Vocabulary:</u> - Electrophoresis - Forensics</p>
<p><u>Students Will:</u></p> <ul style="list-style-type: none"> - Understand how molecules are separated based on their size and charge. - Understand how varying lengths of DNA can be separated using gel electrophoresis - Understand how to read a gel with different DNA samples. - Understand that DNA is made of base-pairs that can be used as a unit for DNA length 	<p><u>Materials:</u></p> <p>For Each Group (3-4 students)</p> <ul style="list-style-type: none"> <input type="checkbox"/> Plastic Box <input type="checkbox"/> 2-12cm pieces stainless steel wire <input type="checkbox"/> 2 Wire leads w/alligator clips <input type="checkbox"/> 5-9V batteries <input type="checkbox"/> Plastic comb <p>For Class</p> <ul style="list-style-type: none"> <input type="checkbox"/> Baking soda <input type="checkbox"/> Agar-agar powder <input type="checkbox"/> Mat knife <input type="checkbox"/> Food coloring <input type="checkbox"/> Glycerine <input type="checkbox"/> 5-Needle tip pipets (one for each dye) <p>Teacher Will Need to Provide</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scale <input type="checkbox"/> Microwave <input type="checkbox"/> Glass Pyrex beaker <input type="checkbox"/> Stirring rod <input type="checkbox"/> 5 Test tubes (for preparing dyes) <input type="checkbox"/> Rulers
<p>Safety</p>	<p>Students need to be careful to not put fingers on electrodes or in the solution when circuit it connected. Might get a slight shock.</p>
<p>CCMR Lending Library Connected Activities: Extracting DNA</p>	



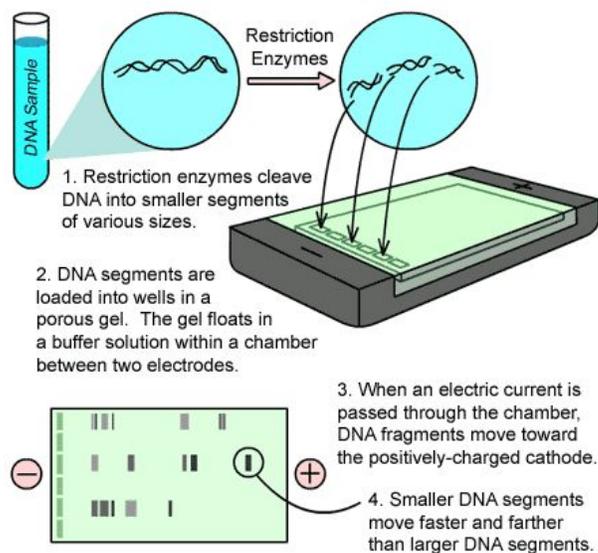
Science Content for the Teacher:

What is gel electrophoresis?

Gel electrophoresis is a laboratory technique used to visualise DNA on a gel where the DNA molecules are separated according to their size. This can allow scientists to detect alterations in the DNA sequence which may cause a genetic condition.

How does gel electrophoresis work?

Figure S-2: Gel Electrophoresis



The DNA being visualised is normally a product of PCR which is performed first to make sure enough copies of the section of DNA being analysed for it to be seen. Gel electrophoresis works by using an electric current to pass DNA samples through a gel. The gel acts like a sieve allowing smaller DNA molecules to migrate through the gel quicker than larger molecules. The gel is then visualised under UV light where DNA samples appear as bands. Bands which have migrated further down the gel are smaller than those which have not moved as far.

DNA is added into wells at the top of a pre-made gel. The gel is submerged in a tank of liquid. A power pack can be attached to the tank.

An electric current is applied across the gel. As DNA is negatively charged it will move from the well towards the bottom of the gel. The gel acts like a sieve, separating different DNA molecules according to their size, as smaller DNA molecules will be able to move through the gel quicker than larger molecules.

When the gel is being prepared a chemical is added to it, this chemical will bind to the DNA and is visible under UV light. The DNA molecules will then appear as series of bands on the gel.

What do the results from gel electrophoresis mean?

The image seen under UV light is photographed so it can be analysed. A series of DNA bands will be visible on the gel, and how far they have migrated through the gel will depend on their size.



The PCR will have been set up so scientists can detect the presence or absence of certain sections of DNA which may indicate an alteration to the DNA sequence; for example one band may only be present if there is an alteration in this section of the gene.¹

Classroom Procedure:

Before Class - Prep for 10 Groups:

Buffer solution (0.2% sodium bicarbonate):

Dissolve 2 grams of baking soda in 1 liter of water.

1% Agar Gel Solution:

Dissolve 10 g of agar-agar to 1L of sodium bicarbonate buffer.

Heat the gel solution in the microwave until it starts boiling. Heat the solution at 15 second intervals, mixing it after each interval. It should take about 75 seconds total. The solution will turn clear.

You can make the solution and then heat it in separately in smaller beakers.

Dye samples:

Mixing 2 drops of food coloring with 1 mL water in a small tube. You might want to have students test with just two of the dyes (red/blue and yellow/green) to avoid confusing with well has what color. They can then share results.

During Class:

1) Set the comb 1cm from the top edge of the gel box (marked on the box). Next, add the warm agar gel solution to the gel box such that the comb teeth are submerged approximately 0.5 cm. Let the gel set for approximately 7-10 minutes.

We suggest you do this before the class and have not included this step in the activity sheet. You can show an example with the students.

2) Have students follow rest of procedure on activity sheet. **Note: Wires do not have to be touching the gel!**

3) Once they hook up the batteries, it will take 15 minutes for the dye to run through the gel. While waiting for the results, you can discuss gel electrophoresis and its applications further (pre-read and presentation) or have them work on activity 2.

4) After 15 minutes, students will collect data (colors and distance used), then use this data to create a graph to answer the aim of the experiment.

¹ "Gel electrophoresis - National Genetics Education Centre." 2013. 8 Dec. 2015
<<http://www.geneticseducation.nhs.uk/laboratory-process-and-testing-techniques/gel-electrophoresis>>



Assessment:

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

- 4= exceeds expectations
- 3= meets expectations consistently
- 2= meets expectations occasionally
- 1= not meeting expectations

	Engage	Explore	Explain
4	Shows leadership in the discussion and activities on gel electrophoresis. Shows an understanding of separation of molecules based on weight and charge in a gel matrix. Also, understands how gel electrophoresis is used in forensics to separate DNA of varying sizes.	Completes work accurately while providing an explanation for what is observed. Works very well with group.	Provides an in depth explanation of findings. Fills out worksheet clearly.
3	Participates in the discussion and activities on gel electrophoresis. Shows an understanding of separation of molecules based on weight and charge in a gel matrix. Also, understands how gel electrophoresis is used in forensics to separate DNA of varying sizes.	Completes work accurately and works cooperatively with group.	Provides clear explanation of findings. Fills out worksheet clearly.
2	Contributes to the discussion, but shows little understanding of gel electrophoresis and DNA gel electrophoresis.	Works cooperatively with partner, but makes some mistakes with the procedure.	Provides a limited explanation of findings. Fills out some of the worksheet.
1	Does not participate in discussion. Shows no understanding of gel electrophoresis or use of gel electrophoresis in separating varying sizes of DNA.	Has trouble working with partner. Does little to complete the procedure.	Is not clear in explanation of findings. Does not fill out worksheet.



Resources:

"Gel Electrophoresis." *Exploratorium*. N.p., 07 Apr. 2016. Web. 30 Nov. 2016.
<https://www.exploratorium.edu/snacks/gel-electrophoresis>

"Kids Ahead - Genetics Activities - Gel Electrophoresis Virtual Lab." *Kids Ahead - Genetics Activities - Gel Electrophoresis Virtual Lab*. N.p., n.d. Web. 29 Nov. 2016.
<http://kidsahead.com/subjects/18-genetics/activities/363>

"Biology Animation Library." *DNALC Blogs*. N.p., n.d. Web. 30 Nov. 2016.
<https://www.dnalc.org/resources/animations/gelectrophoresis.html>

Khanacademymedicine. "Gel Electrophoresis | Chemical Processes | MCAT | Khan Academy." *YouTube*. YouTube, 17 Sept. 2013. Web. 07 Feb. 2017.
<https://www.youtube.com/watch?v=mN5lvS96wNk>

"Virtual DNA Fingerprinting"
<https://ny.pbslearningmedia.org/resource/tdc02.sci.life.gen.creatednafingerprint/create-a-dna-fingerprint/#.WLbgYhIrJyw>

"How to sequence your DNA"
<http://www.pbs.org/wgbh/nova/body/sequence-DNA-for-yourself.html>

Extension Activities:

https://www.biologycorner.com/worksheets/who_ate_the_cheese.html

