TEACHER GUIDE

A Look inside the Lab: Gel Electrophoresis

OVERVIEW

The VMP Next Step Science resources provide mini lessons, videos, and other materials related to the practice of science. These resources are meant to enhance the exploration of a particular topic or offer insights into the profession of scientific research.

The Next Step Science "A Look inside the Lab" series is comprised of reading passages and videos designed to introduce students to pieces of laboratory equipment and the scientists who use them. The series can be used to enhance an existing lesson or as a starting point for introducing a concept.

Each mini lesson includes:

- Short video featuring scientists from the Children's Hospital of Philadelphia Research Institute discussing their work and how they utilize the lab equipment on a day-to-day basis
- Related reading passage
- Teacher guide
- Student worksheet

Additional VMP "A Look inside the Lab" videos and materials can be found at vaccinemakers.org/next-step-science.

OBJECTIVES

"A Look inside the Lab" series activities are designed to:

- Introduce students to equipment commonly used in medical research laboratory settings and explore how the technology impacts and serves society
- Introduce students to scientists, science careers, and the types of investigations that scientists conduct on a day-to-day basis
- Provide an opportunity for students to read informational text about scientific topics enhance their understanding of how science is done, and consider how scientists develop possible solutions to problems

LESSON RESOURCES

- Lesson video, *A Look inside the Lab: Gel Electrophoresis,* https://vimeo.com/527280917
- Video transcript PDF: https://vaccinemakers.org/sites/default/files/resources/Look_Lab_Gel_Electro_video_transcript_FINAL.pdf
- Reading passage, *Using Gel Electrophoresis to Test for Medical Conditions in Newborns,* https://vaccinemakers.org/sites/default/files/resources/Look_Lab_Gel%20Electro_reading%20passage_FINAL.pdf
- Student worksheet: https://vaccinemakers.org/sites/default/files/resources/Look_Lab_Gel-Electro_worksheet_FINAL.pdf
- Student activity sheet, Screening Panel Tests activity (Activity 1), for "explain" section: https://vaccinemakers.org/sites/default/files/resources/Look_Lab_Gel_Electro_Activity1_screening_panel_FINAL.pdf
- Advisory Committee on Heritable Disorders in Newborns and Children Recommended Uniform Screening Panel, https://www.hrsa.gov/advisory-committees/heritable-disorders/rusp/index.html
- U.S. Dept. of Health & Human Services, Recommended Uniform Screening Panel Guidance Portal, https://www.hhs.gov/guidance/document/recommended-uniform-screening-panel
- Articles on the process of gel electrophoresis:
    - What is gel electrophoresis https://www.yourgenome.org/facts/what-is-gel-electrophoresis
    - What Does Gel Electrophoresis Involve? https://www.news-medical.net/life-sciences/What-Does-Gel-Electrophoresis-Involve.aspx
- Interactive gel electrophoresis simulation, LabXchange, https://www.labxchange.org/library/items/lb:LabXchange:9548bee3:lx_simulation:1
    - Note: Scroll to the bottom of the page to access versions of the simulation in multiple languages.
- Instructions to build your own gel electrophoresis device:
    - Gel electrophoresis Science Snack activity, Exploratorium, https://www.exploratorium.edu/snacks/gel-electrophoresis
    - Kitchen electrophoresis activity, Wellcome Trust Centre for Human Genetics, https://bioprep.community.uaf.edu/wp-content/uploads/sites/339/2013/07/Kitchen-electrophoresis.pdf
- Video demonstrations of running a gel:
    - Gel Electrophoresis Lab, ScienceCreAchins, https://www.youtube.com/watch?v=uKwSxPgqS3U
    - Running an Agarose Gel, University of Leicester, https://www.youtube.com/watch?v=U2-5ukpKg_Q

LESSON

The lesson progression outlined below can be completed in one 90-minute class or be split over two class periods. If the "Extension" activity is included one or two more class sessions may be required.

Engage
Time: 10-15 minutes
Have students:

- Discuss what they are familiar with regarding how information about a person's DNA serves a purpose or solves a problem. Examples might include tracing family ancestry using DNA samples, using DNA evidence to help solve a crime, or checking DNA to diagnose a genetic condition. This can be done as a class or in small groups.
- Ask the students to speculate on how information about DNA is translated into a visual form.

Explore
Time: 10-15 minutes
Have students:

- Read the passage, *Using Gel Electrophoresis to Test for Medical Conditions in Newborns*.
- Ask students to write down one question they had regarding gel electrophoresis after reading the passage and set it aside for the "elaborate" section of the lesson.

Explain
Time: 20- 30 minutes
Have students:

- Divide the class into small groups for the "Screening Panel Tests (Activity 1)" assignment. If time is limited, assign each student a test and have them do the research outside of class time.
- Give each group one disorder from the provided list or allow them to choose. Additional disorders can be found on the Advisory Committee on Heritable Disorders in Newborns and Children Recommended Uniform Screening Panel.
- Have groups research the disorder and complete the table on the activity sheet:
    - Identify the classification of the disorder (metabolic disorder, etc.)
    - Briefly describe the disorder.
    - Describe information about the testing needed to screen for the disorder. Ask students to include any information about the lab processes that they find to be used for these tests. Because some of the tests may be difficult to find the

information for, particularly depending on the time and research abilities of your students, you may want to make this a bonus item.

- After the activity, if time allows, have each group share a fact or something interesting that they learned about the disorder they researched.

Elaborate
Time: 20 - 30 minutes
Have students:

- Watch the short video, *A Look inside the Lab: Gel Electrophoresis*.
- Explore resources to understand the process of gel electrophoresis. (Suggested options can be found in the lesson resources section of this teacher guide.)
- Look at their questions from the "explore" section of the lesson and use the resources to research and answer their questions if their question was not answered during the testing research or video viewing activities.
- Complete worksheet focused on the lab process of gel electrophoresis.

Evaluate
Time: 15-20 minutes
Have students:

- Design an infographic explaining how gel electrophoresis works.

Extension (Optional)
Time: Variable
Have students:

- Engage in the process of preparing and running a gel. If your school does not have the appropriate laboratory facilities or equipment, the lesson resources include DIY options for building a gel electrophoresis device out of household materials or using an online simulation offered by LabXchange.

RUBRIC - ACTIVITY 1: Screening Panel Tests

List of disorders:

1. Biotinidase deficiency (BIOT)
2. Congenital adrenal hyperplasia (CAH)
3. Congenital hypothyroidism
4. Cystic Fibrosis
5. Galactosemia
6. Homocystinuria
7. Maple syrup urine disease
8. Medium chain acyl-CoA dehydrogenase deficiency (MCAD)
9. Phenylketonuria (PKU)
10. Sickle cell disease (SCD)

Reference U.S. Dept. of Health & Human Services, Recommended Uniform Screening Panel Guidance Portal: https://www.hhs.gov/guidance/document/recommended-uniform-screening-panel

Gel electrophoresis may be employed for each of the diagnostic tests featured in the lesson (see above list).

RUBRIC: STUDENT WORKSHEET

1. What is gel electrophoresis?
   Students should be able to mention:
   - Gel electrophoresis is used to separate molecules like DNA or proteins
   - The separation of molecules is based on size and electric charge

2. Explain the process by which DNA is separated in an agarose gel.
   - DNA samples are prepared and put into wells at one end of the gel
   - An electric current is applied causing the DNA to move (migrate) through the gel
   - Since DNA has a negative charge, the molecules move through gel towards the positive electrodes

3. Would you find the largest or the smallest fragment of DNA closest to the bottom of the gel once the gel electrophoresis process is complete? Explain your answer.
   - The largest fragment will be closer to the top because larger fragments migrate more slowly through the gel.
   - Smaller fragments move through the gel more quickly and, as such, will end up at the bottom of the gel.

4. Give three examples of how gel electrophoresis can help scientists.
    - Note that student answers will vary. Scientists use gel electrophoresis to:
        - Analyze genes associated with a genetic disorder
        - Separate DNA fragments for crime scenes investigation
        - Determine ancestry (e.g. such as a paternity test)
        - Study proteins
        - Identify different species or determine evolutionary relationships in populations or species
        - Learn about antibiotic resistance
        - Analyze results of polymerase chain reaction
        - Analyze macromolecules