

# The Gene Hunters

## Activity 1: Grades 5-8

### Build an Electrophoresis Chamber

In "[Gene Reader](#)" you learned all about the Human Genome Project from Whitehead Institute Director [Eric Lander](#). Now you'll get to try out for yourself one of the techniques used by scientists to isolate DNA. Electrophoresis is a laboratory technique that can separate a variety of mixtures, including strands of cut DNA. Samples are placed in slot-like wells of a conductive gel. Positive and negative electrodes inserted at opposite ends of the gel generate a surrounding electric field. Reacting to this field, molecules of the sample migrate outward within the gel material. The distance and speed at which they move from the well depend upon particle size and charge. Over time, molecules of similar size and properties will migrate, collect, and form distinct bands or regions. By analyzing these bands, scientists can "build" a model that represents this DNA sequence.



### OBJECTIVE

This activity page will offer:

- Assemble a gel chamber for separating mixtures
- Observe separation influenced by electric charge
- Operationally define separation through gel electrophoresis

### MATERIALS

- Plastic ice cube molds
- Aluminum foil
- 9 volt battery
- Connecting wires with alligator clips
- Scissors
- Buffer solution (as prepared by your instructor) \*\*
- Medicine dropper (or fine laboratory pipette)
- Warm liquid agar solution \*\*\*
- Food coloring (various colors)

## **TEACHER'S NOTE**

- \* Prior to this activity, use a small saw to carefully separate a plastic ice cube tray into sections with 2 or 4 individual molds.
- \*\* Prepare 1 gram of baking soda in 100 ml of water
- \*\*\* Prepare 1.0 grams non-nutrient agar in 100 ml of water. Agar is available at health food stores.

## **PROCEDURE**

### **Part 1- Setting the Gel**

1. Clean and dry two mold chambers of an ice cube tray.
2. Obtain the cooling agar solution as prepared by your instructor.
3. Carefully pour this solution into each of the tray chambers.
4. Leave undisturbed or place the tray in a refrigerator to accelerate solidification of the gelatin.

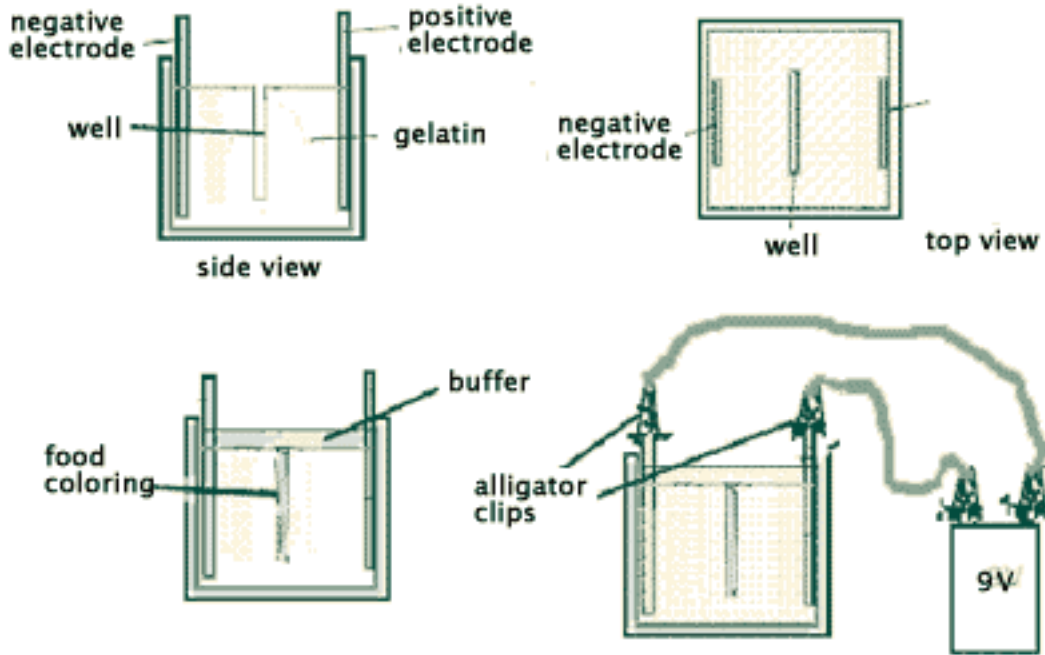
### **Part 2- Building the Chamber**

1. Construct a blade-like tool to cut into the solid gel by folding a piece of aluminum foil into a stiff rectangle about 1 cm wide by 5 cm long. The "blade" should have the thickness of about five sheets of foil.
2. Use this folded strip to poke a slot-shaped well into the gelatin. The well should be positioned at about the midline of the chamber. Use this tool to poke, cut, and remove the gel material so that a thin (less than 1 mm) rectangular slot is created.
3. Cut two strips of aluminum foil (about 1 cm by 4 cm) for the chamber electrodes. Insert these along opposite inner sides of the mold.  
SEE DIAGRAM

### **PART 3- Running the Sample**

1. Flood the agar surface with buffer solution. A layer of about 3 mm of buffer must cover the top of the gel and fill the rectangular well.
2. Fill your pipette or medicine dropper with green food coloring. Immerse the tip in the buffer and position it at the bottom of the well. Slowly release some of your sample and observe how it flows upward and fills the well. Continue releasing the sample until the well is filled. Carefully remove the tip of the pipette or dropper from the chamber, trying not to disturb the buffer solution.  
SEE DIAGRAM
3. Use alligator clips to connect a 9-volt battery to the exposed tops of the aluminum foil terminals. Wait one hour.
4. Examine the gel. What do you see?  
NOTE: You can increase the speed of the separation by wiring up several 9-volt batteries in a series.
5. Reattach the electrodes and continue examining the gel at 30-minute intervals. Record your observations.

6. Repeat this procedure on other food coloring samples using the remaining gel chambers.



## ANALYSIS

1. How has the gel changed?
2. Did the coloring spread out evenly in all directions?
3. Did the green food coloring change shades? Which Traveled the furthest?
4. Did the other food colorings separate into the same bands as the green?

## EXTENSIONS

### Accelerated Demonstration

Your instructor can demonstrate a much quicker separation using a laboratory power supply that produces about 45 volts. At this voltage, a satisfactory separation of food coloring is achieved in about 30 minutes time.

### Think About It

Molecules of DNA have an overall negative charge. If you were to perform electrophoresis on DNA, at which side of the well would you observe the formation of DNA bands? Why?

When examining the separation bands of DNA, you discover that the smaller fragments of DNA travel the greatest distance from the well. Why?

### Electrophoresis and HIV

Did you know that this same technique is used to create a confirmatory test of HIV called the Western blot assay? HIV proteins are obtained from laboratory cultures and separated out using gel electrophoresis. These distinct and characteristic bands are "blotted" onto a test strip. The test strip is placed in

contact with blood serum samples. If the serum contains HIV antibodies, it will bind to the specific protein bands and confirm a previous exposure (and immune response) to HIV. Conduct a search on the World Wide Web to learn more about this procedure.

## **WEB CONNECTION**

### **[DNA - An Interactive Study Guide](http://dlab.reed.edu/projects/vgm/vgm/VGMProjectFolder/VGM/RED/RED.ISG/)**

*<http://dlab.reed.edu/projects/vgm/vgm/VGMProjectFolder/VGM/RED/RED.ISG/>*  
A great introduction and overview of DNA, mapping, and gel electrophoresis techniques.

### **[Electrophoresis Chamber](http://gslc.genetics.utah.edu/basic/gel/)**

*<http://gslc.genetics.utah.edu/basic/gel/>*  
This site as step-by-step instructions for constructing a sturdy classroom electrophoresis chamber using Plexiglas.

### **[Agarose Gel Electrophoresis of DNA](http://arbl.cvmbs.colostate.edu/hbooks/genetics/biotech/gels/agardna.html)**

*<http://arbl.cvmbs.colostate.edu/hbooks/genetics/biotech/gels/agardna.html>*  
An advanced site for instructors showing how to prepare and run DNA gels.

For more Web links on this topic - visit our [Resources Section](#).

The activities in this guide were contributed by Michael DiSpezio, a Massachusetts-based science writer and author of "Critical Thinking Puzzles" and "Awesome Experiments in Light & Sound" (Sterling Publishing Co., NY).

#### **Academic Advisors for this Guide:**

Corrine Lowen, Science Department, Wayland Public Schools, Wayland, MA  
Suzanne Panico, Science Department, Fenway High School, Boston, MA  
Anne E. Jones, Science Department, Wayland Middle School, Wayland, MA

# The Gene Hunters

---

*Activity 1: Grades 5-8*

## Build an Electrophoresis Chamber

### Answers

### Analysis

1. How has the gel changed?  
**(there are bubbles at the electrodes, the gel has softened, the food coloring has spread into the gel)**
2. Did the coloring spread out evenly in all directions?  
**(No. The color broke up into connected smears that spread varying distances from the well)**
3. Did the food coloring change shades?  
**(Yes - The green separated out into regions of blue and yellow. The yellow traveled the furthest.)**
4. Did the different food colors separate into the same bands? **(No - each color separated into its own smear of component colors.)**

### Think About It

Molecules of DNA have an overall negative charge. If you were to perform electrophoresis on DNA, at which side of the well would you observe the formation of DNA bands? Why? **(On the positive side of the well since opposite charges attract.)**

When examining the separation bands of DNA, you discover that the smaller fragments of DNA travel the greatest distance from the well. Why? **(Smaller size particles make fewer collisions with the molecules that form the gel matrix. With fewer collisions, their movement is less affected than the migration of larger (more frequently colliding) particles.)**