UPDATE (September 2017): A full version of this lab is now available from the miniPCR Store

Rainbow Gel Electrophoresis Lab

Background

You may have heard the saying "opposites attract" referring to friendship or relationships, but it's actually true in science. Negatively charged molecules move towards positive charges and positively charged molecules move towards negative charges. This principle is used in a process called *gel electrophoresis*, which sorts molecules according to their size and electrical charge. Gel electrophoresis places samples between one negatively charged pole and one positively charged pole, so you can tell the charge of a sample based on which way it moves. This process can be used to compare DNA samples, like using fingerprints to solve crimes! Gel electrophoresis can also be used to look at anything that has different sizes and charges, like food coloring. In this lab, you'll use gel electrophoresis to discover the size and charge of different food dyes.

Materials

- blueGel™ electrophoresis system (can be adapted for other devices)
- 0.4 g of agarose per gel
- Food coloring
- 40 mL of 1X TBE buffer per gel
- Micropipette 2-20 µL
- Disposable micropipette tips
- Piece of white paper 2.5 inches x 3.5 inches
- 150 mL 5% glycerol (can use household products, like Vaseline Body Lotion, or corn syrup, that are not dyed)

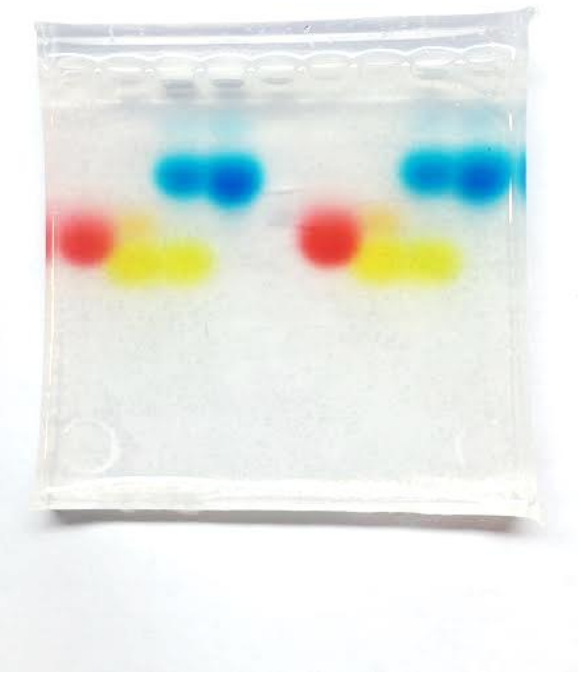
Protocol

I. Gel electrophoresis

A. Pouring the agarose gel (can be done before the lab)
   1. Place a 9 well-forming comb at the negative end of a clean and blueGel™ tray
   2. Create agarose buffer by mixing 0.3 g of agarose per 15 ml of buffer
   3. Heat the mixture in a microwave until the solution becomes clear (~35 seconds)
   4. Cool the mixture for 2-3 minutes at room temperature
   5. Pour the cooled mixture into the gel-casting tray (with the comb in the 9 well side)
   6. Allow the gel to become solid and then remove the comb

B. Run the gel
   1. Place white piece of paper (2.5" x 3.5") on the blue base (under the buffer chamber)
   2. Place the gel in the buffer chamber and completely cover it with 1X TBE electrophoresis buffer (~25 ml of buffer)
   3. In plastic cups, mix 1 drop of dye with 30 mL of 5% glycerol

4. Load 15 ml of each dye samples into each well (keep track of which color went in each well)
5. Put on the orange cover, press the power button, and run electrophoresis for ~20 min
6. Once dyes have migrated halfway along the gel, take the orange cover off
7. Record where each chemical dye moved in the gel
   a. Hint: shining a flashlight at the gel may make it easier to see
   b. Hint: a picture like this one might help!



Understanding the Protocol

Each part of the gel electrophoresis does an important job in separating the samples.

1. Agarose actually comes from seaweed! The agarose gel creates a substance that molecules move through based on size. The gel is thick in a way that makes it easier for smaller molecules to get through it.
2. Plugging the device into a power source provides energy for each of the poles to have a charge, so one side is negative and the other is positive.
3. TBE buffer conducts electricity. This means it works like a wire, allowing each sample to move towards the pole it's attracted to.

Follow-up questions

- Did the different dyes move different distances?
- Did the dyes move the way you predicted they would?
- What did we learn about the dyes? (sizes, charges)
- What would make a dye migrate in the opposite direction?
- What do you think would happen if you used more concentrated sample of each dye?
- What do you think would happen if you ran the gel for an hour?
- What was the role of the buffer? The agarose gel?

What to do next

- Try running the lab with mixtures of the dyes
- Try running the gel for different amounts of time to see if you can get a clearer picture of how far the samples move

Extended Version: Extracting Your Own Dyes

Background

Many foods today are dyed to make them look appealing, even though it doesn't add to the taste or nutritional benefits! The world consumes 15 million pounds of artificial dye every year, that's 5 times more than was used in 1955. These dyes are very common in M&Ms and other colored candies and can be used in gel electrophoresis just like food coloring! This lab lets you discover the size and charge of the dyes taken off candies, just like was done with food coloring.

Materials

- 4 colored candies, such as M&Ms
- 15 uL of dye extraction buffer per candy
- 4 plastic cups

Protocol

1. Put each candy in a cup with a label of what color the candy was
2. Add 0.5 ml of dye extraction buffer to each cup
3. Swirl the candy in the cup until you get to the white layer of the candy
4. Pipette 15 uL of the liquid from the cups into one well each
    a. Just like the food coloring samples used earlier
5. Follow the original protocol using the extracted samples instead of food coloring!

Understanding the protocol

The dye extraction buffer is there to take the dye off the candy (like its name suggests). The dye on these candies works for gel electrophoresis just like food coloring because they are basically just stronger versions of the dyes you use when baking!