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Gel Electrophoresis with Food Dyes

Background

You may have heard the saying "opposites attract" referring to friendship or relationships, but it's actually true in science. Negatively charged molecules are attracted to positive charges and positively charged molecules are attracted to negative charges. This principle is used in a process called gel electrophoresis, which separates molecules according to their size and electrical charge. During gel electrophoresis, samples are loaded between negative and positive electrodes. Then an electrical current is run between the two electrodes. The direction the samples follow in the electrical current reveals their charge. This process can be used to analyze DNA samples. Gel electrophoresis can also be used to study other charged molecules, 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 or Bandit™ STEM electrophoresis kit (can be adapted for other devices)
- One Agarose Tab™ or 0.5 g of agarose powder per gel
- Food coloring
- 60 ml of 1X TBE buffer per gel
- Micropipette 2-20 µl or a 10 µl fixed volume micropipette
- Disposable micropipette tips
- Piece of white paper 2.5 inches x 3.5 inches
- Glycerol or table sugar
- Small plastic cups or 1.7 ml microcentrifuge tubes

Protocol

A. Pour agarose gel (can be done before the lab)

If using a blueGel™ electrophoresis system

1. Prepare casting platform: Place the clear gel tray in the white casting platform.
2. Place a 9 well-forming comb in the center of the gel tray.
3. Dissolve an Agarose Tab™ in 20 ml of distilled water OR combine 0.4 g agarose powder with 20 ml 1X TBE buffer.
4. Heat until the solution boils and continue until agarose is dissolved and solution becomes fully transparent (about 60 seconds).
5. Pour the agarose solution into the prepared casting platform with a gel tray and comb.
6. Allow gel to solidify completely (about 10 min) and remove the comb by pulling firmly upwards.

For video instructions, please visit: https://www.minipcr.com/agarose-gel/

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If using a Bandit™ STEM Electrophoresis Kit

1. Place the Electrodams™ at the ends of the buffer chamber with the tall side facing the center.
2. Place the comb supports over the sidewalls of the buffer chamber.
3. Place the 6-well-forming comb in the center of the buffer chamber, resting over the comb. supports. Ensure the comb is as straight as possible.
4. Dissolve an Agarose Tab™ in 30 ml of distilled water OR combine 0.5 g agarose powder with 30 ml 1X TBE buffer.
5. Heat until the solution boils and continue until agarose is dissolved and solution becomes fully transparent (about 60 seconds).
6. Pour the agarose solution into the prepared Bandit™ with Electrodams™ and comb.
7. Allow gel to solidify completely (about 10 min) and remove the comb, comb supports, and Electrodams™ by pulling firmly upwards.
8. Prepare the electrodes by threading approximately 8 inches of wire through both of the small holes in the channel of the Electrodam™. Repeat with second Electrodam™ but thread the electrode wire from the opposite side.
9. Insert the Electrodams™ into the buffer chamber with the electrode wire near the bottom of the buffer chamber, facing the gel.
10. Connect one alligator clip to the free end of the wire threaded through each Electrodam™. It may help to wrap the electrode wires around the alligator clips to ensure good contact.
11. Plug the wire connected to the alligator clips into the round port on the right side of the Bandit™ circuit controller.
12. Plug the USB-C cord into the USB-C port on the left side of the Bandit™ circuit controller.
13. Plug the other end of the USB-C cord into your power source, but complete part B before pluging the power source into an outlet.

For more detailed instructions visit: https://links.minipcr.com/bandit-assembly-pdf

B. Run the gel

1. Place white piece of paper (2.5” x 3.5”) under the buffer chamber.
2. Place the gel in the buffer chamber and completely cover the gel with 1X TBE electrophoresis buffer (~25-30 ml of buffer).
3. In plastic cups or microcentrifuge tubes, dissolve 1/4 teaspoon of table sugar in 1 tablespoon of hot water.
4. Measure out 1 teaspoon of the sugar water mixture into a new tube, add 1 drop of food coloring of the desired color and mix. Repeat for additional colors.
5. Load 10 μL of each dye sample into each well (keep track of which color went in each well).
6. If using a blueGel™, put on the orange cover and press the power button. If using a Bandit™, ensure aligator clips are connected and plug in the device.
7. Run electrophoresis for approximately 20 min.

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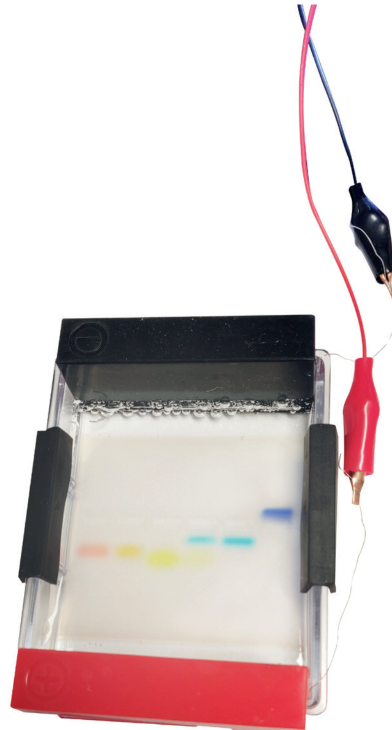
8. If using a blueGel™, remove orange cover, record how far each dye moved from the well and in which direction (+ or -).
   Hint: shining a flashlight at the gel may make it easier to see.
   Hint: a picture like this one might help!



Understanding the protocol

Each component of gel electrophoresis has an important job in separating the samples.

1. Agarose actually comes from seaweed! The agarose gel creates a web or sieve through which molecules move based on size.
2. Plugging the electrophoresis system into a power source provides electrical load, 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.

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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?
- Were the dyes made up of one molecule or a mixture of molecules?

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.

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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 five times more than was used in 1955. These dyes are very common in M&M's 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 used in candies.

Materials

- 4 colored candies, such as M&M's, gumballs, or Skittles
- 2.5 ml of dye extraction buffer (see recipe below) per candy
- 4 plastic cups

Prepare Dye Extraction Buffer

Dissolve 3/4 teaspoons table sugar in 3 tablespoons of warm water. Allow to cool before use.

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. Follow the original protocol. Prepare dye extraction buffer 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 food coloring you buy at the store is often made up of the same dye molecules that are used to color candies. Compare you candy dye electrophoresis results to your food coloring electrophoresis results. Can you tell which dyes were used in your candy?

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