Leader Guide

Food Dye Chromatography

Objective

Chromatography is a process that separates the components of complex mixtures. Students use the process of Chromatography to determine what colors make up the mystery dye colors.

Introduction to Kids' Lab

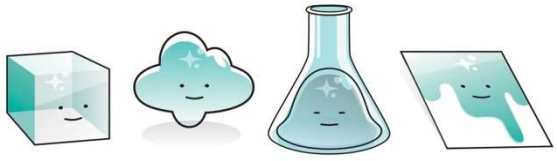
Welcome to the BASF Kids' Lab. BASF is the world's largest chemical company and run Kids' Lab programs like this all around the world. Use the suggested guide below to lead this experiment.

Instructor guide

- Can anyone think why BASF has this program?
  - BASF wants children all over the world to understand and enjoy experimenting with chemistry!
- Has anyone heard that word before: Chemistry?
- What do you think it means?
- **Chemistry is the science of matter.**
- Have you heard the word “matter” before? What is matter?
  - Matter is anything that takes up space and has a weight here on earth. So basically, matter is a scientific word for stuff.
  - Chemistry is a science that explores the composition of substances and their properties and reactions. In other words, Chemistry is a science that explores how different stuff behaves.
  - Matter comes in a few different forms or states: Solids, Liquids and Gases are the most common.
- Chemistry is all around us.

  For example:
  - Who takes a vitamin?
  - How do vitamins help you? (Grow big and strong, boost immunity).
- BASF makes chemicals that go into vitamins.
  - Raise your hand if you play a sport or ride a bike.
  - What should you do to be safe? (Wear a helmet, pads, etc.)
  - What materials make up the helmets that you wear? (Plastics and foam)
- BASF makes chemicals that go into the plastics and foams in helmets and padding.
- Besides helping you grow strong and keeping you safe when you are playing your favorite sport, BASF chemistry keeps farmers crops safe, cleans water for those in need and keeps babies clean and dry.
- Let me introduce you to morpH, the face of Kids’ Lab.
- morpH can move through the three states of matter with ease.
- Is there a substance that you know of, like morph that can easily shift from solid to liquid to gas (and back again)?
  - Water! That’s right!
  - You know that water is usually liquid but what happens when you freeze water?
  - Water becomes a solid ice cube.
- What happens when you boil water?
  - Water becomes a gas.
- Water is one of the most important substances on earth.
- Not only does water make life possible, but it can be used to create beautiful works of art.

morpH and I would like you to **explore Chromatography**.



Experiment Introduction

Chromatography is the process of separating mixtures of different chemicals into individual components. Chemicals in a mixture usually have different chemical properties, such as molecule size or the ability to dissolve in different kinds of solutions. Chromatography is a technique used to analyze the components of a mixture and has applications across many scientific disciplines.

There are several types of chromatography such as paper, thin layer, column, and gas chromatography. For all chromatography techniques, there are two phases, the mobile phase, and the stationary phase. In the mobile phase, there is some mixture in one state of matter, such as a gas or a liquid. The stationary phase is typically a solid state of matter and does not move as the mobile phase moves across it.

In this activity, filter paper is the stationary phase and water is the mobile phase. This type of chromatography is called paper chromatography. Water is a solvent that is absorbed into the paper by capillary action. The different colors in the food dye are the mixture solution that we are trying to separate into different components or pigments of color.

Make sure you are familiar with the following terms:

Chromatography: the separation of a mixture by passing it in a solution or as a vapor through a medium.

Solution: a liquid mixture where the minor component, the solute, is universally and uniformly distributed within the major component, the solvent.

Solvent: a fluid that molecules dissolve in.

Capillary action: the phenomenon whereby a liquid is able to flow through narrow surfaces despite external forces like gravity. This is due to an interaction between the surface tension of a liquid and the attraction to a solid surface.

Stationary Phase: an unmovable or fixed substance that will restrict the movement of substances that are not dissolved by the mobile phase. In our case, the stationary phase is paper.

Mobile phase: a solvent like water that moves through the stationary phase.

Additional Background Information

Chromatography was first used in the early 1900s by Russian botanist, Mikhail Tsvet to research pigments from plants. He called the technique chromatography which is derived from the Greek words “chroma” which means color and “graphein” which means to write. With chromatography, Tsvet was able to separate green chlorophyll pigments and yellow xanthophyll pigments found in plant leaf extracts. Today, there are multiple chromatography techniques used for a variety of purposes.

All chromatography techniques involve a mobile phase and a stationary phase. The stationary phase is usually a solid like paper, a glass plate coated with a thin layer of absorbent material, or a column packed with silica gel. The mobile phase is usually a liquid or solvent that contains the sample that you are analyzing. In gas chromatography (GC), a gas is the mobile phase, and the gas moves through a liquid or solid stationary phase.

As the mobile phase moves through the stationary phase, different components of the mixture will separate based on different chemical properties. These chemical properties include: the solubility of the components in the solvent used, the size of the molecules in the mixture and the attraction of the molecules towards the stationary phase. For example, a large molecule may move through the stationary phase much slower than a smaller molecule. This is one-way chromatography is used to separate different components of a mixture.

Chromatography is frequently used by chemists to analyze known and unknown substances. By separating the components of a mixture, scientists can analyze and identify each component of a mixture individually. Chromatography can be used in forensic analysis to determine the identity of unknown substances. Similarly, chromatography can be used to detect illegal substances in human or food samples. Chromatography is frequently used in the pharmaceutical industry to purify the ingredients of medicines. Furthermore, manufacturers routinely use chromatography to detect contamination and ensure quality of final products.

For this chromatography activity, it is important to know that the molecules in the food dye have different properties and characteristics, such as size and solubility. Remember that solubility is the ability for molecules to dissolve in different fluids, and a solvent is the fluid that the molecules dissolve in. Because food dye has different molecules with different characteristics, the molecules will migrate at different speeds through the paper. The large and heavy molecules in the ink won't move as far as the small and light molecules. Therefore, they move at different speeds and settle in different places on the filter paper as the water travels through the filter paper.

In our experiment, the salt water (mobile phase) moves through the filter paper (stationary phase) because of capillary action, where the surface tension of the water interacts with the surface tension of the paper. As the water migrates, it dissolves and carries some of the dye molecules with it. When the water flows through the mystery-colored dye, the molecules of the different colors will behave differently. This difference creates the separation of the different colors within the mixed samples and allows you to see what colors make up the "Mystery" dyes.

Safety Guidelines

Lab safety is a must! In order to safely explore Chemistry, we need to follow proper lab safety. How do you think we are going to do this? Chemists follow very strict procedures to protect themselves and they include:

- Gloves
- Safety glasses
- Lab aprons or lab coats

Before we get started:

- Be sure everyone including instructors and helpers are wearing safety glasses.
- Point out any safety features in the classroom (ie. Eyewash or emergency shower; emergency exits).
- Mention housekeeping rules – NO EATING OR DRINKING.
- Mention location of bathrooms.

Food Dye Chromatography

Materials

Filter paper with hole punched in top (optional) and line drawn about an inch from bottom

- Food coloring (red, blue, yellow, mystery colors 1,2,3)
- Pipet tip for applying dye
- Salt water (5% salt in water)
- Reagent reservoirs or shallow dish
- Pencils for labeling filter paper

Step 1: Write Your Name on the Filter Paper

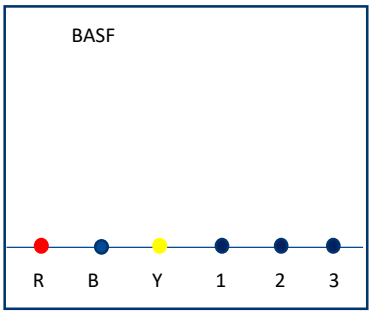
Obtain a piece of filter paper and write name on top in pencil.

Step 2: Collect the Dye with the Pipet

Cover the flat end of the pipet tip with your thumb. Put the tip of the pipet into a tube of dye and use suction to get some dye in the tip.

Step 3: Spread Dye on Filter Paper

Place the loaded tip unto the line drawn on the filter paper. Remove thumb from end and allow dye to leak onto the paper. Continue Step 3 until there is a spot for each of the colors including the mystery ones. Label which color was used beneath each dot of dye with a pencil.



Step 4: Fill the Reservoir

Fill the reservoir with the salt water to a level just below the line on the filter paper, about ¾ inch.

Step 5: Place Filter paper in the Salt Water Solution

Hold filter paper in the reservoir. Be sure that the paper is in the water, but the water level is below the location of the dye spots.

Step 6: Watch the Dye Move

Observe the movement of the dye across the paper.

- At each step, engage in dialogue with the audience. Encourage them to verbalize observations. Which of the three primary colors moved the furthest? Does that make that dye color molecule larger or smaller than the other colors? What colors are in the mystery colors?

Summary

Chromatography is used to separate molecules with different properties that are in a mixture. In our Chromatography experiment, we used filter paper as the stationary phase and salt water as a solvent and mobile phase. As the salt water moved through the filter paper by capillary action, it dissolved food dye pigments and carried these colors through the paper. The different pigments within each color separated and you could see the various pigments that the color contains. What color moved the fastest and furthest on the paper? What does this migration pattern tell you about the various food dye colors?