Group Members:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pharmaceutical Company:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### Race to Find the Cure

**Student Instructions and Questions**

**Summary:** This activity simulates the extraction, identification and separation of chemicals in or on plants using chromatography. Students work in groups representing different pharmaceutical companies racing to find the miracle cure for cancer.

**Materials (per group):**

1 sheet Whatman #1 filter paper 3 weigh boats

2 pencils distilled water

2 rulers 100 mL beaker

2 pairs of scissors 2 ring stands

3 vials containing unknown extracts string

3 plastic pipettes 3 paper clips

**Background Information:**

Chromatography is a physical method to separate the parts of a mixture. There are a variety of types of chromatography using gases, gels, electric charges, glass tubes, etc., but this activity uses a simple type called **paper chromatography**.

You will use filter paper and put a small amount of each of your samples near the end of the paper strip. The tip of the paper will be placed in water. The water acts as a **solvent** and the sample dissolves into it. As the water moves up the filter paper because of capillary action, the sample will percolate up the filter paper as well. The filter paper is called the **stationary phase**. The sample dissolved in the water is called the **mobile phase**.

Your group will receive three samples to test. Each sample contains different chemicals. These chemicals will show up as different colors in today’s simulation. A sample may contain one or more chemicals. In your samples today, you will be looking for mixtures with one or two different chemicals. The chemicals will be represented by different colors on the strips of chromatography paper. The different colors that represent each chemical will move along the filter paper at different rates. Some colors travel faster and farther than others, so the different colors spread out along the filter paper. The end result is called a **chromatogram**.

Why do some colors travel faster than others? Some pigments are more soluble in the water, so they move at a faster rate. The size of the pigment molecule is also a factor. Larger molecules travel more slowly, thus less far up the filter paper.

**Directions:**

1. Break into small groups representing different pharmaceutical companies.
2. Make your own chromatography strips using one sheet of Whatman #1 filter paper. You will cut 3 strips that are each 9 cm long x 2 cm wide. Use a pencil and ruler for accurate measurements.
3. Using a pencil and ruler, mark each blank chromatography strip with two horizontal lines. One line should measure 2 cm from the bottom; the other line should measure 4 cm from the top.
4. At the top of each strip, use pencil to label one sample number from each of your vials of unknown extracts.
5. Place two ring stands far enough apart so that 3 weigh boats can fit in between with some space (~1”) between each weigh boat.
6. Tie a piece of string to each rod approximately 10 cm up from the base of the ring stand. If the string slips down, secure with tape.
7. Apply the unknown extracts (your three samples) using pipettes along the bottom (2cm) line on the chromatography paper, one sample per strip. Be sure to use a different pipette for each vial so there is no cross-contamination.
8. Hang each chromatography strip from the string using a paper clip; be sure to center each strip over a weigh boat.
9. Fill each weigh boat with approximately 50 mL of distilled water, just enough to allow only the tip of each strip to dip into the water. (Do not allow the sample along the 2 cm line to be placed directly in the water, or it will dissolve into the water, rather than move up along the strip!)
10. Remove the weigh boats when the water reaches the top (4 cm) line on the chromatography strip. This will occur after approximately 10-15 minutes. Allow the strips to hang to dry for a few minutes. Then, lay the strips flat.
11. While waiting for your chromatograms to finish, discuss the following questions with the members of your pharmaceutical company. Write the answers on this instruction sheet (as you will discuss them with the class later).
    1. Why do you think the chemicals separate?
    2. How do you think this technique can be useful?
    3. Why would we want to separate chemicals?
    4. **\*Advanced Question**\* - Based on what you know about molecules, what are some other potential chromatographic or separation techniques?

12. Your samples each contain one or two chemicals (i.e. A, B, A/B, C/D, etc.). You will try to identify them by comparing your chromatograms to the standards already prepared by your teacher (chemicals A, B, C, and D). But, some samples may contain a chemical that does not match the standards. This is the “unknown” and could be a cure for cancer! Do you think you have the “unknown chemical”?

Sample #\_\_\_\_ contains chemical(s)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Sample #\_\_\_\_ contains chemical(s)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Sample #\_\_\_\_ contains chemical(s)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

13. After you have determined the chemicals on each of your strips, you will isolate the chemicals on the strip. You do this by extracting the separated chemicals from the chromatography paper. Cut out the “individual” colors/chemicals from the chromatogram. Place each fraction into a separate weigh boat containing distilled water. Observe the chemical dissolve into the water. **You have now isolated a chemical!**

14. Discuss the answers to the following questions with the members of your pharmaceutical company and write down your answers.

* 1. What are some challenges you can see from trying to extract/isolate a chemical?
  2. Plants can vary in the amounts of compounds they contain within a species or even with in a given plant. What are some factors you can think of that can affect the amount of chemical a plant produces?
  3. How can this variation affect you as a consumer?