

## Naturally Dyes Experiment

### AUDIENCE:

This is a lesson targeted for Grades 4-7 and can be linked with STEAM curriculum. While written as an activity, it can also be modified into an inquiry based lesson for older scientists. For younger scientists it can be adapted to be an experiment on color mixing. This activity is written as an egg dying experiment but can be modified as natural watercolors and for naturally dying pasta (see Resource Corner).

### **LEARNING OBJECTIVES:**

- 1. Scientists will ask questions, make inferences, and create a **hypothesis**
- 2. Scientists will learn how to make dye from natural ingredients
- 3. Scientists will compare their questions, inferences, and/or **hypothesis** with the results

### **STANDARDS CONNECTION:**

Science and Engineering Practice:

- Asking Questions and Defining Problems Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships
- Planning and Carrying Out Investigations Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution
- Analyzing and Interpreting Data Analyze and interpret data to make sense of phenomena using logical reasoning

#### **VOCABULARY:**

**Natural Dye** - colors that come from plants and minerals

**Hypothesis** - a guess based on what you already know about what will happen **Acid** - substances or compounds with pH of <7 that often taste sour

- **Base** substances or compounds with pH >7
- **Neutral** substance with a pH of 7

#### **MATERIALS:**

- Natural Dye Ingredients:
  - Half Large Red Cabbage chopped
  - 2-3 TBSP Fresh sliced or Powdered Turmeric
  - 2 Beets
  - <sup>1</sup>/<sub>2</sub> teaspoon Baking Soda
- Eggs (pre-hard boiled or washed out shells)
- White Vinegar
- 4 cups of water per Dye Ingredient
- Saucepan (multiple if you have them)
- Cheesecloth, fine mesh sieve, or strainer
- Small bowls/jars (large enough for one egg)
- Drying rack (see Resource Corner for suggestions)
- Egg wire holder or spoon (see Resource Corner for DIY instructions)
- Adult: should participate/be present during experiment



#### • VIDEO Introduction

#### **ACTIVITY SOURCES:**

- <u>The Incredible Egg</u>
- <u>Science Project: The Chemistry of Dyeing Easter Eggs</u>



### Set-up

Depending on how engaged you want your scientist to be, complete the steps under ACTIVITY as needed. Make dyes ahead of time if you simply want to test how different **natural dyes** will look or include your scientist in the whole procedure. If you want to put your scientist in control of the experiment present them with a problem and/or materials (i.e. "How could we use these materials to dye eggs?")

• Decide ahead of time if you want to hard boil eggs to dye or save empty egg shells. When saving egg shells, wash them right after use to prevent odors.



### I: Introduction (5 minutes)

Time to ask questions! Introduce your scientist to this experiment by explaining **natural dyes** and the materials for the lesson. Have your scientist come up with their own questions given the materials or if needed ask your scientist open ended questions such as:

- a) What will happen when we dunk an egg in dye made from \_\_\_\_\_?
- b) What ingredients do you think would dye an egg \_\_\_\_\_ color?
- c) What other ingredients do you think we could use to make **natural dyes**?

Use the Know, What I Want to Know, and What I Learned (KWL) Chart at the bottom of this activity to further guide the experiment. In this section fill out the "Know" column with information the scientist already knows. Write any questions or ideas under the "What I Want to Know" column.

Create a **hypothesis** with your scientist using an "If... then..." statement. (i.e. "**IF** I use spinach to make a **natural dye**, **THEN** then the egg will dye green.") See the Resource Corner for more Experiment/**Hypothesis** Ideas.

### II: Activity (time varies from 1 hour - overnight)

Follow the steps to make **natural dyes**. If you are using this as an experiment with a scientist, create your own or use the Observation Sheet at the bottom of the lesson to track observations.

1. In a saucepan, add one of your **natural dye** ingredients and 4 cups of water.





- 2. Bring mixture to a boil, reduce the heat to medium low and simmer for 15 minutes or more based on the color you want. Remove from the heat.
- 3. Strain dye mixtures into separate bowls/jars (to strain turmeric powder use a cloth/paper towel in the bottom of the strainer). With the red cabbage dye, divide evenly in thirds. Set two bowls/jars of red cabbage dye aside.



4. To mix other colors use additional bowls/jars (see picture for different combination suggestions). Start with beet or cabbage dye and add tumeric dye little by little because it is very strong.





- 5. Add 2 teaspoons of white vinegar for each cup of dye liquid to your bowls/jars except your two red cabbage jars (you will have less liquid than you started with and may need to remeasure your dye liquid).
- 6. In the red cabbage jars you set aside add 1/2 teaspoon of baking soda to each. Then add vinegar to just one of these jars.

Take note of what happens when you add vinegar to the cabbage dye, both with and without baking soda. See Resource Corner for more information.

If allowing a scientist to create the experiment record observations during this step. Ask your scientist to give their best guess for what is happening and discuss later. You could suggest or have them complete the experiment without vinegar to compare results. Ask your scientist if they know of another **acid** they can try.

- 7. Gently place the egg in the bottom of a small bowl or jar. Pour the dye mixture making sure to completely cover the egg.
- 8. Let the egg stand in dye for three hours or overnight. If using hard boiled eggs keep bowls/jars in the refrigerator. If using the Observation Sheet write down your first observation at "0 minutes" when you began the experiment. (see note in Resource Corner for additional experiment options)
- 9. With egg wire or spoon gently remove egg from dye, set on drying rack. If using hard boiled eggs place the eggs in the refrigerator after they dry.

### III: Evaluate (5 minutes)

Work with your scientist to explain what happened in the experiment (see Resource Corner form more information). Have a discussion around their observations and why they think they got these results. If you used the Observation Sheet or KWL Chart, have your scientist review their understanding from the beginning of the experiment and elaborate on their understanding afterwards. Did they find any answers to their questions? Was their **hypothesis** correct? Do they have more questions? Have your scientists write what they learned in the "L" column and add any new questions at the bottom of the chart. Can your scientist think of a way to answer these questions?

## **Resource Corner**

### Relevant Background Information and Experiment Alternatives

- DIY Egg Wire Holder (Adult) wearing safety/work gloves cut 8 inch section from wire hanger using wire cutters. Using pliers, create a loop about 1 inch in diameter. Bend handle to create 90 degrees angle from the loop. At the top of the handle create another small loop about ½ inch in diameter.
- DIY Drying Rack using a cardboard box cut holes 1 inch in diameter. Create enough holes for the number of eggs you are dying.
- WATERCOLORS use the same steps for boiling ingredients and color mixing
- 5



colors but omit the 2 teaspoons of vinegar.

- PASTA DYES precook pasta to al dente, soak in hot natural dyes for 5-10 minutes.
- Additional Experiments:
  - o Do tests at different time intervals. Have scientists develop a **hypothesis** of what will happen if you leave the eggs in the dye for longer. Check on the eggs at decided intervals (e.g. every 30 minutes for an hour) take pictures and compare at the end of the experiment.
  - Do the experiment with brown and white shelled eggs. Have scientists develop a **hypothesis** for what they think the difference will be between the two.
  - o Complete the experiment without vinegar or with more vinegar.
  - Other Ingredients to Try: yellow onion skins, spinach leaves, yellow delicious apple peels, red grape juice, strong brewed coffee, canned blueberries, fresh cranberries, orange/lemon peels, dill seeds, frozen raspberries, carrot tops, celery seed, chili powder, ground cumin
  - Complete the experiment but instead of dying eggs try dying pasta, just skip the vinegar!
- Baking Soda Explanation: Everything is made of chemicals and they fall on a scale called the pH scale. Red cabbage is **neutral**, it falls right in the middle and has a pH of 7, because of this we can consider red cabbage an **acid/base** indicator. When we add an **acidic** substance (pH < 7) to the red cabbage dye it would turn red. When we add a **basic** substance (pH > 7) to the red cabbage dye it turns blue like in this experiment.
  - For Older Scientists: The pigment that gives red cabbage it's purple-red color is anthocyanin. Anthocyanins are pigments belonging to the flavonoid family. These pigments are water-soluble, meaning they can be lost in water. They are also particularly sensitive to pH.



• Vinegar Explanation - Vinegar is an **acid**. When we add it to the red cabbage dye it turns the dye red. Vinegar is needed to bond the dye to the egg through a chemical reaction. Like a magnet, the vinegar creates a positive charge in the dye that gets drawn to the negative charge of the egg's calcium shell all through hydrogen bonding. If you see bubbles when you place your egg in the dye this is carbon dioxide.





Hypothesis:
If:
Then:

Additional Question(s):		



# Natural Egg Dyes Observation Sheet

Using the observation table below write or draw a picture of what the egg looks like every 30 minutes for 3 hours. To help, set a time for 30 minutes so not to forget. Write in your own color combinations in the last two columns!

	Beets	Cabbage	Cabbage with Baking Soda	Turmeric	
0 minutes					
30 minutes					
1 hour					
1 hour 30 minutes					
2 hours					
2 hours 30 minutes					
3 hours					

