OBJECTIVE

✓ Learn about the real science behind plant-based ingredients

MATERIALS

✓ Mortars and pestles
✓ Red Cabbage
✓ Paper
✓ Vinegar
✓ Baking soda
✓ Small bowls for cabbage juice
✓ Paintbrushes

INSTRUCTIONS

1. Cabbage Pigment Painting
   a. Take a few leaves of red cabbage and put them in your mortar.
   b. Pour a small amount of vinegar in the mortar.
   c. Grind the leaves up using the pestle. You will see the color start to come out of the cabbage.
      1. What color is it? Red
      2. What does the vinegar do? Vinegar keeps the red color present in the ink.

4. Paint with the red ink on the watercolor paper.

5. In a separate mortar, make more red cabbage ink using the previous instruction.

6. Add baking soda to the mixture and use the new color to paint.
   a. What color is it? Blue
   b. What does the baking soda do? It acts as a mordant or fixative which changes the color by changing the acidity of the liquid.

BACKGROUND INFORMATION

Cabbage Pigment Painting

✓ Pigments: When referring to plants—different pigments within the leaf or plant part color the plant and can help the plant photosynthesize. For example, chlorophyll is a pigment. These same pigments can be used to make dyes or inks and paints.

✓ When referring to artistic things, pigments are typically used to refer to colors which are applied to, but do not penetrate, a surface. They are applied as washes or as oil paints. For our class, this refers to the INK we are making. When referring to a dye, most use it to mean a substance that when dissolved penetrates and chemically binds to the material involved. They are used mostly on textiles or leather.
Dyes, inks, paints, etc. can all be made from plant pigments.

Pigments for artistic purposes can be natural (i.e. derived from plants, animals or soils) or man-made.

Photosynthesis: is the process by which plants use the energy from sunlight to produce sugar. The sugars (food) are then used by the plant to provide energy for growth.

Chlorophyll: is the pigment (molecule, protein) in plants (located in the chloroplasts) that captures sunlight energy and uses it to drive photosynthesis. Chlorophyll looks green because it absorbs red and blue light and reflects green light, making these colors unavailable to be seen by our eyes.

Other pigments in plants: Beside chlorophyll, there are other pigments in plants. Some of these pigments help in photosynthesis and some do not.

Carotenes (such as carotene, lycopene and xanthophylls) are red, yellow and orange. These pigments are masked by the chlorophyll colors in most leaves. We see these colors in tomatoes (lycopene), carrots, mango, fall leaves, and yams. As chlorophyll breaks down in tree leaves in the fall in temperate areas, these colors are more easily seen.

Flavinoids such as anthocyanin are typically reds and purples in fruits and vegetables such as blueberries, blackberries, tea, eggplant and red cabbage.

Pigments used in making inks and paints: People have been using the pigments in plants to make paints and inks for thousands of years. Before you could buy paints in the store, you had to make your own.

Historians and scientists believe that prehistoric animal skins and cave paintings dating back to 15,000 B.C. were dyed with plant pigments (among other things including soils and charcoal. The charcoal coming from burned logs—i.e. plants). The most famous ancient paintings are probably the Lascaux cave paintings in France.

They’ve also recently analyzed examples of an ancient Egyptian quiver (it holds arrows) dating to around 2000 B.C. and identified the red dye as coming from the madder plant. One of the oldest pieces of writing on papyrus known to us today is an Egyptian Papyrus which dates back to 2000 B.C.

The history of Chinese inks can be traced back to the 12th century B.C., with the utilization of natural plant (plant dyes), animal (squid ink), and mineral inks based on such materials as graphite that were ground with water and applied with ink brushes.

Oak galls, which are easy to find here in PA or NJ in the fall, were once used as a source of black ink. Galls are a growth on the leaf of the plant typically caused by a small insect (often a wasp) laying its eggs in the leaf. The leaf grows extra structures around the growing insect to protect and feed it.

Some common plants used to make dyes include walnuts (brown), indigo (blue), onion skins (yellow), lichens (pink or brown), spinach and kale (green) and strawberries and cherries (pink) and madder (red).

The dyes and inks from plants are NOT always the color of the plant. They are often the color of some of the masked pigments. In addition, the colors
can change based on the mordant (fixative) used in the dye solution. For instance, fabric dyed with something as vivid as red beet juice usually turns out a shade of brown or tan. Red cabbage will change its color depending on the pH of the mixture. Vinegar makes a pink color and baking soda makes a blue color.

- **Madder** — which has a yellow flower — makes a red dye from its roots
- **Indigo** — which has a pink flower — makes a blue dye
- **Woad** — which has a yellow flower — makes a blue dye