LESSON 9

Local Color: Dyeing With Plants

Grade level: 6-12
Subject Areas: Biology, chemistry, art, history
Duration: 3-4 class periods
Setting: Classroom/lab, field site for plant collecting
Season: Spring, Summer or Fall (anytime if plants are collected ahead of time)
Conceptual Framework Topics: Humans and plants, ethnobotany

OBJECTIVES

Students will learn about ethnobotany by exploring ways Native Americans and Europeans utilized plants, practice plant identification skills; and extract and use plant dyes from hand-collected, locally growing material.

METHOD

Students discuss the importance of plants in historical and modern settings. A hands-on activity helps students to identify, collect, and extract dye from locally growing plants to naturally dye a final product. Select plant identification skills are cemented when students determine and draw the key distinguishing features of their local plant of choice.

MATERIALS

- **Local Dye Plants** information sheet
- Plant identification guides
- Drawing/coloring utensils and white paper
- A few each of: spades, trowels, clippers
- Used grocery bags
- Plain white T-shirts (either students' old shirts or ones newly purchased) or other fabric (you may want to have students experiment with different types of materials)
- Mortars and pestles, blender, or other implements for crushing or grinding plants
- Paintbrushes (optional)
- If boiling and steeping plant material: hot plates, steel pots, cheesecloth, rubber bands, ladles or large slotted spoons to scoop hot materials out of water
- Latex gloves to protect hands from possibly allergenic plants
- Alum (aluminum potassium sulfate) found in spice section of grocery stores or drugstores (optional)

BACKGROUND

The study of how humans relate to plants is *ethnobotany*. Past and present uses of plants in Montana include food, shelter, medicine, fuel, clothing, and ornamentation.

People have been creating dyes to color clothing for thousands of years. The earliest written record for dyeing dates back to 2600 B.C. Before people

learned how to make dyes from chemicals, plants were used to create dyes (along with minerals and animal substances). It was a very difficult process to extract enough dye to color whole pieces of clothing. It was even more difficult to make the dye permanent, to prevent it from washing out when the clothing was washed. This was accomplished by using a mordant (substance for colorfastness) of various forms. Consequently, in the early days of dyeing cloth, often only royalty and the very wealthy could afford it. As dyeing became more common and more could afford it, certain colors (usually purple or blue) became reserved for royalty. Records show that dyeing was practiced by many different cultures all over the world. Prior to the European migration to the Americas, Native Americans had been dyeing their fabrics for many years. When Europeans settled in the Americas, they learned some of the native dye plants, and they brought with them many plants known for their good dyeing properties. Some of these plants are considered weeds in the Americas today. For example, the Puritans brought dandelions to the colonies in the 17th century, using the plants to obtain yellow color from the flowers and magenta from the roots.

Dyes are organic compounds that selectively absorb some colors (visible wavelengths) and reflect others. Different dyes are soluble in different liquids (water, alcohol, etc.). Most dye molecules have at least 3 types of chemical groups which contribute to their properties. The *chromophore* produces the color, the *auxochrome* controls the intensity of the dye and the chemical bonding to the fabric, and the *solubolizing group* allows it to disolve in a liquid.

In the dye bath the dye molecule may be neutral or ionize. Although the dye fragment may be either a cation or anion, most natural dyes are anionic. These are also known as acid dyes because they work best in slightly acidic baths. The anionic dye forms a strong bond with a fabric that has a cationic bonding site. For more information on the chemistry of plant dyes, see the ***Resources*** section of this guide.

PROCEDURE

1. Have a class discussion about the importance of plants in our everyday lives. Ask students to list items they use during the day that come from plants. Discuss the different uses of plants in the past and present. Lead a discussion on why early Montanans, Native and European, used dyes from plants. Why couldn't they just buy dyes? How did imported goods and new technology change that? Do people still use plant dyes today? Discuss present craft traditions of hand dyeing for artistic yarns, cloth, and other items as a legacy of early people influencing our culture. Have students predict what it is like to use plant dyes – how long does it take to dye cloth, how many steps are there, how difficult is it? Discuss throughout the lesson the chemistry of dyeing.

Dyeing Activity

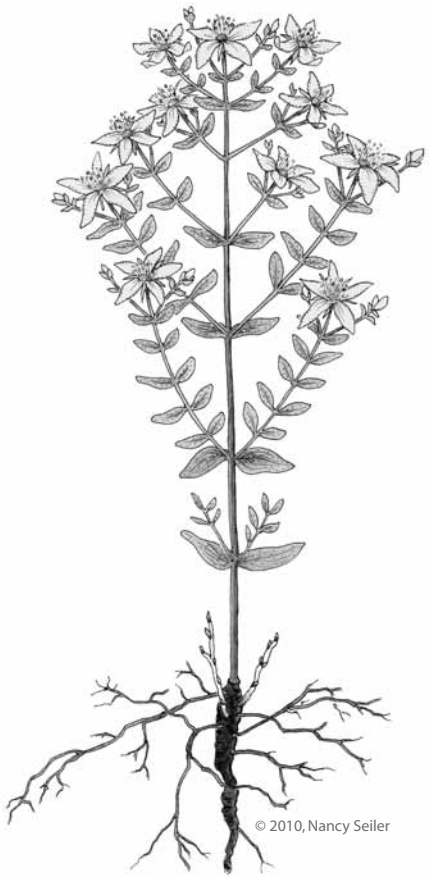
2. Prior to conducting this activity, educators should acquaint themselves with dye plants (listed in Local Dye Plants sheet) growing locally, possible field trip locations for collecting those plants, and what stage of growth plants are in at the time. (Alternatively, the teacher could collect plants in spring or fall for use at a later time in the school year when plants may not be accessible.) You should also determine the amount of time available for this activity and the desired results. Some dyeing procedures require lengthy steeping times, while simple crushing of berries and flowers can be done much more quickly, although with lower quality results.

3. Have students select from the list of available local plants the species of his/her choice. Because native plants are important components of healthy functioning ecosystems, students should either select non-native plants or very abundant and widespread natives. When native species are used, harvest no more than 5% of the total population. The student should then determine what the key diagnostic features are for his/her chosen plant and draw a replica of the plant to later aid the student in field identification.

4. Take students on a field trip to a pre-determined destination where all chosen plant species can be collected. Students must use their drawings and field plant identification guides to identify their chosen plant species. Using trowels, spades, clippers and used grocery bags, have students collect their chosen plants, making sure that key plant parts are properly collected. The amount needed will vary depending on the amount and type of material to be dyed, the intensity of the dye, and the type of plant used. In general, 2-3 pounds of plant material will make about 4 gallons of dyebath.

5. Once back in the classroom, if you wish to apply a mordant such as alum to the material to make it colorfast, complete the following (you may want to do this step as the plant dyes are steeping):

- Using a stainless steel pot, dissolve 5- ½ oz. of alum in 4 gallons of lukewarm water. Wet the material you wish to dye and then immerse it in this mixture with a wooden spoon. Bring it slowly to a boil for 20 minutes.
- Remove it from the mordant bath, wring it out and place it in the prepared dyebath or paint with dye. Alternatively, you can add plant material and water to mordanted water.



St. Johnswort
Hypericum perforatum

Extensions

Learn about different materials Native Americans and Europeans used for clothing and experiment dyeing samples of each of these.

Try dyeing cornhusk dolls or homemade paper.

Experiment with different techniques of dyeing, looking at the importance of each of the following on how well or how long the fabric holds the dye: mordant versus no mordant, type of fiber, temperature, time, freshness of the plant material.

6. To prepare the dyebath, select the appropriate procedure below.

- If extracting dye using simple crushing and painting: Lay T-shirts out on open surfaces and have students crush a variety of the collected parts (berries, flowers, and leaves) with mortars and pestles. Using paintbrushes, students can paint the scene of their choice on their white T-shirt canvas. Allow to dry for 24 hours.
- If extracting dyes via a steeping procedure: Set steel pots on hot plates as students are rinsing plants under running water. Crush, grind, or tear plant parts up as much as possible, using a mortar and pestle or blender. Wrap needed plant parts in cheese cloth, fasten with rubber bands, and place in pots, covering the bundle with water. Apply heat 30-60 minutes or until a heavy concentration of dye has been released to color the water. The steeping time will vary depending on the desired color and chosen plant part. While plants are steeping, have students prepare mordant or take notes on the process they are following. Alternatively, split this part of the activity into two sessions, steep plants overnight, and proceed to the next step the following day.

7. When steeping of the plant material is finished, add hot water to make up to 4 gallons of dye. At this point you can remove the cheese cloth and dye materials.

8. Add fiber or mordanted fiber to be dyed to pot and continue to boil, stirring occasionally to even out the color. Check for depth of fiber color by lifting it up with a wooden spoon. Dry fiber will be lighter in color than when wet. Try adding another teaspoon of mordant if the color is weak.

9. When the desired color is reached or after one hour, take pot off the boil and set aside to cool. When water is cool, remove the dyed fibers from the pot. Wearing latex gloves, wring the dye water from the fiber back into the pot or into a sink.

10. Rinse loose dye and plant fibers from the dyed fiber with clean water under a faucet at room temperature.

11. Hang dyed fiber to dry. *NOTE: When sending material home with students, if mordant was not used, it is important to send a note home with students, warning against the washing of the dyed shirts with other clothing as the hand-extracted dye will bleed.*

12. At the end of the project, have them discuss their predictions, results, problems and successes. Have them think about and discuss why some fiber artists and fiber wearers today might prefer natural dyes.

LOCAL DYE PLANT INFORMATION

Common Name	Scientific Name	Parts Used	Preparation	Colors	Native Status
Black cottonwood	*Populus trichocarpa*	Buds or fruits	Boil	Buds: yellow Fruits: red, green, yellow, purple	Native
Blueberry/ huckleberry/cranberry	*Vaccinium spp.*	Berries	Crushed, mixed with water, or boiled	Navy blue	Native
Bush cranberries	*Viburnum spp.*	Berries	Crushed, mixed with water, or boiled	Red-pink	Native
Common sunflower	*Helianthus annuus*	Flowers or seeds	Flowers: crushed or boiled Seeds: boiled	Flowers: yellow Seeds: black or purple	Native
Oregon grape	*Mahonia repens*	Shredded bark	Boil	Brilliant yellow	Native
Elderberries	*Sambuscus spp.*	Berries	Crushed, mixed with water, or boiled	Crimson, lavender or violet	Native
Goldenrod	*Solidago spp.*	Flowers	Crushed or boiled	Yellow	Native
Alder	*Alnus spp.*	Bark and twigs	Boil	Red-brown or orange	Native
Green rabbitbrush	*Chrysothamnus viscidiflorus*	Mature flowers, buds, twigs	Boil for several hours	Flowers: lemon yellow Buds and twigs: yellow-green	Native
Juniper	*Juniperus spp.*	Bark, berries, needles	Boil	Brown	Native
Mountain hemlock	*Tsuga mertensiana*	Inner bark	Boil	Red-brown	Native
Skunkbush sumac	*Rhus trilobata*	Leaves	Boil	Black	Native
Narrow-leaved yucca	*Yucca glauca*	Leaves	Boil	Red	Native
Stinging nettle	*Urtica dioica*	Roots	Boil	Yellow	Native
Strawberry blite	*Chenopodium capitatum*	Flower clusters	Crushed, mixed with water, or boiled	Maroon	Native
Western gromwell	*Lithospermum ruderale*	Roots	Boil	Red	Native
Western hemlock	*Tsuga heterophylla*	Inner bark	Boil	Red-brown	Native
Western serviceberry	*Amelanchier alnifolia*	Berries	Crushed, mixed with water, or boiled	Purple	Native
Witch's hair lichen	*Alectoria spp.*	All	Boil	Yellow	Native
Yarrow	*Achillea millefolium*	Flowers	Crush and boil	Light green	Native
Common mullein	*Verbascum thapsus*	Flowers	Crushed or boiled	Light yellow	Introduced
Dalmatian toadflax	*Linaria vulgaris*	Flowers	Crushed, mixed with water, or boiled	Yellow	Introduced
Dandelion	*Taraxacum officinale*	Flowers or roots	Flowers: crushed or boiled Roots: boiled	Flowers: yellow Roots: magenta	Native and Introduced
Dyer's woad	*Isatis tinctoria*	Leaves	Boil	Blue	Introduced
Purple loosestrife	*Lythrum salicaria*	Flowers	Crushed or boiled	Purple or lavender	Introduced
St. Johnswort	*Hypericum perforatum*	Flowers or stems	Flowers: crushed or boiled Stems: boiled	Flowers: yellow or orange-red depending on mordant Stems: brown red if alum mordant	Introduced
Tansy ragwort	*Senecio jacobaea*	Flowers or leaves	Crushed or boiled	Flowers: yellow Leaves: green	Introduced
Yellow flag iris	*Iris pseudacorus*	Flowers or roots	Flowers: crushed or boiled	Roots: boiled Flowers: yellow Roots: brown or black	Introduced
Yellow starthistle	*Centaurea solstitialis*	Flowers	Crushed or boiled	Yellow	Introduced
Yellow toadflax	*Linaria dalmatica*	Flowers	Crushed, mixed with water, or boiled	Yellow	Introduced