Spark Innovations

Art Academy Curriculum

Spark
Innovations

Colors

Fibers

Silk


Color

The Silent Language of Color

The goal of this strand is to have students become familiar with both natural and synthetic dyes and dye processes and the human history of Color. The fibers dyed in this strand will be used in other strands. As students learn about each color have them practice dyeing fiber in multiple shades of that color using both natural and synthetic dyes, exploring recipes, and discovering techniques through guidance and discovery.

Introduce the topic with a color book such as *One* by Kathryn Otoshi (*Blue is a quiet color. Red's a hothead who likes to pick on Blue. Yellow, Orange, Green, and Purple don't like what they see, but what can they do? When no one speaks up, things get out of hand — until One comes along and shows all the colors how to stand up, stand together, and count*). Or,

Ask students to brainstorm, as a group, and/or individually what colors mean to them. What do they make them think of? What does red mean? Black? Orange? Gold? What do you think colors might mean to others?

An American Indian Legend - Nation Unknown

Once upon a time the colors of the world started to quarrel: all claimed that they were the best, the most important, the most useful, the favorite.

GREEN said: "Clearly I am the most important. I am the sign of life and of hope. I was chosen for grass, trees, leaves - without me, all animals would die. Look over the countryside and you will see that I am in the majority."

BLUE interrupted: "You only think about the earth, but consider the sky and the sea. It is the water that is the basis of life and drawn up by the clouds from the deep sea. The sky gives space and peace and serenity. Without my peace, you would all be nothing."

YELLOW chuckled: "You are all so serious. I bring laughter, gaiety, and warmth into the world. The sun is yellow, the moon is yellow, the stars are yellow. Every time you look at a sunflower, the whole world starts to smile. Without me there would be no fun."

ORANGE started next to blow her trumpet: "I am the color of health and strength. I may be scarce, but I am precious for I serve the needs of human life. I carry the most important vitamins. Think of carrots, pumpkins, oranges, mangoes, and pawpaws. I don't hang around all the time, but when I fill the sky at sunrise or sunset, my beauty is so striking that no one gives another thought to any of you."

RED could stand it no longer. He shouted out: "I am the ruler of all of you - I am blood - life's blood! I am the color of danger and of bravery. I am willing to fight for a cause. I bring fire into the blood. Without me, the earth would be as empty as the moon. I am the color of passion and of love, the red rose, the poinsettia and the poppy."

PURPLE rose up to his full height. He was very tall and spoke with great pomp: "I am the color of royalty and power. Kings, chiefs, and bishops have always chosen me for I am the sign of authority and wisdom. People do not question me - they listen and obey."

Finally, INDIGO spoke, much more quietly than all the others, but with just as much determination: "Think of me. I am the color of silence. You hardly notice me, but without me you all become superficial. I represent thought and reflection, twilight and deep water. You need me for balance and contrast, for prayer and inner peace."

And so the colors went on boasting, each convinced of his or her own superiority. Their quarreling became louder and louder. Suddenly there was a startling flash of bright lightening - thunder rolled and boomed. Rain started to pour down relentlessly. The colors crouched down in fear, drawing close to one another for comfort.

In the midst of the clamor, Rain began to speak: "You foolish colors, fighting amongst yourselves, each trying to dominate the rest. Don't you know that you were each made for a special purpose, unique and different? Join hands with one another and come to me."

Doing as they were told, the colors united and joined hands. The rain continued: "From now on, when it rains, each of you will stretch across the sky in a great bow of color as a reminder that you can all live in peace. The rainbow is a sign of hope for tomorrow."

And so, whenever a good rain washes the world, and a rainbow appears in the sky, let us remember to appreciate one another.

Color Wonder

One of these Things is a lot Like the Others, Each of these Has a Place It Belongs…

Begin by giving students a set of color chips that range, ex. from light pink to deep red, and all gradations in between and have them put them in order to form a complete wheel. The idea is to train your student's eye to distinguish between subtle gradations.

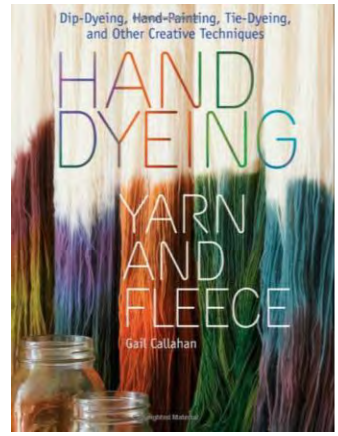
If you open up a box of paints, there are numerous stories hidden inside it. They are stories of sacredness and profanity, of nostalgia and innovation, of secrecy and myth, of luxury and texture, of profit and loss, of fading and poison, of cruelty and greed, and of the determination of some people to let nothing stop them in the pursuit of beauty.- Victoria Finlay, *Color.*

In the historical and chemical paint box you can find corruption, poisonings, wars and politics, killer wallpapers, capital punishment for people using the wrong dyes, endless anecdotes, stories, histories and adventures inspired by the human quest for color. Art history is so often about looking at the people who made the art; but there are also stories to be told about the people who made the things that made the art.

Hue and Cry

When we do not know, really know, where the hues come from, we are somewhat alienated from the process of making them art. In the old days, to learn the secrets of the colors apprentices spent years grinding rocks, powdering roots, burning twigs, crushing dried insects to form them and learning the tricks of their master's trade.

When we study color, and color history, we discover the miraculous processes by which raw materials were ground, washed, purified, heated, precipitated and transformed into beautiful pure pigments through this fusion of chemistry, cookery, alchemy and magic.



Colors to Dye For

Option: A book like Gail Callahan's book Hand Dyeing Fiber and Fleece will be an incredibly helpful resource and reference manual for the projects throughout the dye section. It shows step by step pictures of the techniques described.

Ever since primitive people could create, they have been endeavoring to add color to the world around them. They used natural matter to stain hides, decorate shells and feathers, and paint their story on the walls of ancient caves. Scientists have been able to date the black, white, yellow and reddish pigments made from ochre used by primitive man in cave paintings to over 15,000 BCE. With the development of fixed settlements and agriculture around 7,000-2,000 BCE man began to produce and use textiles, and would therefore add color to them as well. Although scientists have not yet been able to pinpoint an exact time where adding color to fibers first came into practice, dye analysis on textile fragments excavated from archaeological sites in Denmark have placed the use of the blue dye woad along with an as yet unidentified red dye in the first century CE.

Image Credit: Dye pots in Féz. Photo by Janis Turk. http://www.gonomad.com/reflections/1003/morocco-images/dyepots-large.html

In order to understand the art and history of dyeing, we must first understand the process of dyeing itself. According to Webster's dictionary, dyeing is "the process of coloring fibers, fibers or fabrics by using a liquid containing coloring matter for imparting a particular hue to a substance." The colors of dyes and pigments are due to the absorption of visible light by the compounds. Black objects absorb all visible light; white objects reflect all visible light. There are three basic methods of “imparting a particular hue” to a substance.

1. The first is by staining an item, a temporary means of coloration where the color is rubbed or soaked into an item without the benefit of some sort of chemical fixative to preserve the color.

2. The next is the use of pigmentation, wherein the color is fixed to the surface of an object by another adhesive medium.

3. A true dye is when the color of a substance is deposited on another substance in an insoluble (incapable of being dissolved) form from a solution containing the colorant.

Natural dyes can be broken down into two categories: substantive and adjective. Substantive, or direct dyes, become chemically fixed to the fiber without the aid of any other chemicals or additives, such as indigo or certain lichens. Adjective dyes, or mordant dyes, require some sort of substance to prevent the color from washing or light-bleaching out. Most natural dyes are adjective dyes, and do require the application of a mordant (the metal salt) solution to the fibers at some point in the dyeing process.

Wool and hair dye similarly, because they are both ANIMAL PROTEIN fibers (they contain carbon, hydrogen, oxygen, nitrogen, and sulfur) unlike cotton, flax, and rayon which are PLANT CELLULOSIC fibers (they contain carbon, hydrogen, and oxygen). Not all dyestuffs will dye all fibers. Some will dye both animal and plant fibers, but must be treated very differently during the dyeing process.

Something in the water?

Many dyers insist that rain water is better than tap water because it is softer (closer to pH7). Why is it important to use softer water? Is it just to soften the wool? According to some dyers changes in water pH may affect the color produced by some materials, such as the plant Madder, which will only produce orange, not its signature bright red, if the water used is too acid. However, in most cases, water between pH 5.5 and 8.5 does not make an enormous difference to the color produced. If necessary, adjusting the pH of water can be achieved simply by adding a few drops of lemon juice, white vinegar or citric acid to give a lower, more acidic pH or to make it more alkali, add ground chalk, wood ash, or washing soda (borax).

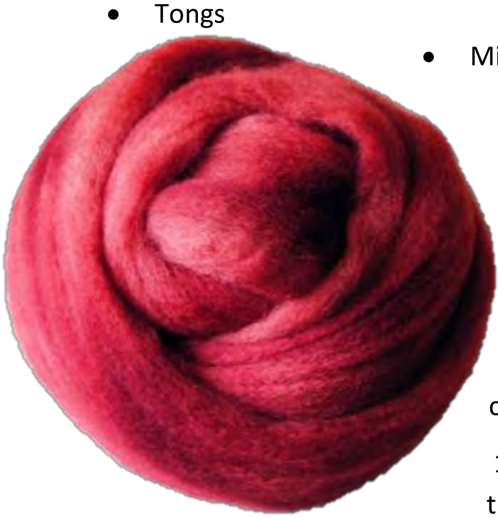
For the dyeing process, an important characteristic of fibers is their porosity. There is a huge number of submicroscopic pores aligned mainly on the longitudinal axis of the fibers such that there are roughly 10 million pores in a cross-section of a normal fiber. The internal surface area therefore is enormous—about 45,000 square meters per kilogram (5 acres per pound) for cotton and wool—some thousand times greater than the outer surface area. To produce deep coloration, a layer of 1,000–10,000 dye molecules in thickness is needed. Upon immersion in a dye bath, the fabric absorbs the aqueous dye solution, and the dye molecules can move into pores that are sufficiently large to accommodate them. Although many pores may be too small, there is an ample number of adequate size to give satisfactory depths of color.

Playing with Food

Have students practice with fibers and learn how they work by playing with grocery store dyes.

Materials:

- Undyed or pale wool fiber **(You are not limited to just dyeing white fiber. Other colors, such as natural grey, produce absolutely stunning results.)**
- A few drops of dishwashing liquid, such as Dawn, in a small bowl of water
- Vinegar-water Solution of 1 part white vinegar to three parts water *[or citric acid (Mix 1 to 1.5 tablespoons of citric acid into each 1 quart (32 oz.) of dye)]*
- Red, yellow, and blue food coloring (you can also use pourable, ready-made, sugar-free drink or freezer pop mix that contains food coloring of the appropriate colors)
- Plastic wrap
- Syringes: Syringes are great for precise placement of dye, for measuring small dye amounts, and for injecting dye inside a bundle of fiber
- Tongs
- Microwave safe bowls and lids
- Microwave
- Spices packed with color, ex. turmeric and chili powder, tea leaves
- Surface protector (ex. plastic grocery or garbage bags) if working indoors.



Prepare the work area by covering it with plastic or going outside. Choose a space that’s large enough for students to pour the food coloring onto the fiber.

1. **Wash the fiber.** Remove any animal oils that might prevent color from penetrating the fiber by immersing the skeins in a bowl of dishwashing liquid and water. Allow them to soak for a few minutes, then gently rinse out any excess detergent.
2. **Soak the skeins.** Immerse the skeins in the vinegar water solution, pushing them gently into the water until they are covered. Let them soak in this solution for 30 minutes, then gently squeeze out any excess water and

vinegar. *(Tip: This 30 minutes is a good time to talk about the following section.)*

3. **Dye the first skein.** Place one of the skeins on the work surface. Pour some of the red coloring onto one half and the yellow on the other half. What happens? Notice that the orange appears where the red and yellow overlap.
4. **Dye the second skein.** Pour blue food coloring on one half of the second skein and red on the other half. What happens? Purple appears where the colors overlap.
5. **Dye the third skein.** Pour yellow coloring on one half of the third skein and blue on the other. What happens? Observe that green appears where the yellow and blue overlap. Add a little red to the yellow, to create orange on this skein as well.
6. **Place the skeins in a bowl.** Wrap each skein separately in plastic wrap, so the colors don't run into one another, and place them in a bowl. Cover bowl with a lid. If you prefer to avoid the plastic wrap, place each one in its own small bowl and use saucers as lids. The lids are necessary to make sure the fiber doesn't dry out and the steam remains in the container.
7. **Apply heat.** Place the bowl in a microwave oven on HIGH for 2 minutes. Allow it to sit for about 2 minutes. Then heat it on HIGH for another 2 minutes.

8. **Remove from heat.** Once the fiber is cool enough to handle safely, use tongs or a spatula to remove the skeins from the bowl and place them in the sink. Allow them to cool to room temperature.
9. **Rinse the cooled fibers.** Use room temperature water to remove any remaining dye.
10. **Test it out.** How would you dye with the spices? What ideas do students have?
11. **Try it without your mordant:** Don't use vinegar. Does it make a difference? What happened? Why might that have happened?

Tip: If testing out Kool-Aid dyes in comparison to pure food coloring students will still use the same ratio of vinegar to water (or citric acid to water) but as a starting point, for each ounce of fiber (spun or unspun) you plan on dyeing, use:

One package of unsweetened Kool-Aid
Liquid (8 oz total): ex. 6 ounces of water 2 ounces of vinegar

If you want the color to be less intense, use less Kool-Aid in the same amount of water. Conversely, more Kool-Aid will give you more color. For consistent results, dissolve the Kool-Aid in the water/vinegar solution and dilute the resulting solution.

A basic color chart follows this page to give you an idea of what colors can be obtained with Kool-Aid dyes when dyeing with white or grey wool.

Kool-Aid Dye Shades on White & Grey Fiber

Dyeing Our Own "Color Wheel"

The key to students unlocking the mysteries of creating our own custom colors is to experiment with different proportions of the primary colors. By decreasing one increment of a primary color and increasing an increment of another, students can achieve an endless number of gradations around the color wheel. It's useful—and fun!—to dye their own samples of the three primaries, as well as the secondaries and tertiaries they can make with them, creating 12 basic colors in all. Grocery store food coloring or dye company colors work well for this project.

To achieve changes in value, add miniscule drops of the complementary color to the dye mixture. Note: A dyestock is the basic dye color, usually mixed with water in preparation for use in a dye mixture. A "dye mixture" is a combination of one or more of the dyestocks in specific ratios, which the students will calculate.

Materials:

- Work surface prepared for dyeing
- 12 small skeins of worsted-weight wool yarn (we will be using raw fiber, this is to give you a comparsion) per student, approximately 20 yards/18m each.
- Vinegar-water solution of 1 part white vinegar to 3 parts water, or citric acid (Mix 1 to 1.5 tablespoons of citric acid into each 1 quart (32 oz.) of dye)
- Yellow, red, and blue food colors, ex. McCormick
- 3+ Quart jars to hold the dyestock
- 12+pint jars for the dye mixtures
- Vinyl gloves
- Syringes: Syringes are great for precise placement of dye, for measuring small dye amounts, and for injecting dye inside a bundle of fiber
- Masking tape
- Permanent marker
- Microwave oven

Method:

1. **Prepare the fiber** Tie the skeins loosely with pieces of scrap fiber to keep them from tangling, and place them in a vinegar-water solution. Soaking removes all the air from the fiber and ensures even dyeing; the acid is our mordant and prepares the fiber to accept the dye. Set the soaking fiber aside while you mix the dyestock.

2. **Mix the dyestock.** Have students calculate and place the following measurements of food coloring in pint jars, adding enough water to each to make 2 cups of dyestock.

   - Jar 1: 1 teaspoon yellow
   - Jar 2: ½ teaspoon red
   - Jar 3: ¼ teaspoon blue
3. **Make the dye mixtures.** Have students line up the 12 pint jars and mix the following amounts of dye stock to create mixtures (marking the jars with the amounts on masking tape as they go, ex: 6tY & 6tB):

   a. Jar 1: 12 teaspoons yellow
   b. Jar 2: 3 teaspoons blue and 9 teaspoons yellow
   c. Jar 3: 6 teaspoons blue and 6 teaspoons yellow
   d. Jar 4: 9 teaspoons blue and 3 teaspoons yellow
   e. Jar 5: 12 teaspoons blue
   f. Jar 6: 3 teaspoons red and 9 teaspoons blue
   g. Jar 7: 6 teaspoons red and 6 teaspoons blue
   h. Jar 8: 9 teaspoons red and 3 teaspoons blue
   i. Jar 9: 12 teaspoons red
   j. Jar 10: 3 teaspoons yellow and 9 teaspoons red
   k. Jar 11: 6 teaspoons yellow and 6 teaspoons red
   l. Jar 12: 9 teaspoons yellow and 9 teaspoons blue
4. Dye the skeins. Drain and squeeze out the excess vinegar (or citric acid) and water from each skein. Add one skein of prepared fiber to each container. Stir to evenly disperse the solution. Allow the fiber to sit in the solution for about 30 minutes.

Going a step further: If you have the time and inclination, you can expand this gradation of colors to a range of 36 by reducing and increasing the amount of dye dilution you add to the 36 pint jars, 1 teaspoon at a time, in the established progression. For instance, between Jars 1 and 2, add two more jars, one with 1 teaspoon blue and 11 teaspoons yellow, the other with 2 teaspoons blue and 10 teaspoons yellow. Do you follow the progression? Note that after Jar 12 you need to add two more jars to complete the "wheel"; 1 with 2 teaspoons red and 10 teaspoons yellow and the other with 1 teaspoon red and 11 teaspoons yellow. This brings you right back to 12 teaspoons yellow and the wheel is complete.

Heat set the dye: Place a pint jar in the microwave and heat on HIGH for 1 minute. (You may be able to heat set as many as four jars at a time depending on the strength of the available microwave.) If the water is clear all the dye has been absorbed by the fiber and they can remove the jars from the microwave, taking care not to burn their hand. If the water still shows color heat for another minute or until the water clears

What is a mordant and what does it do?

Highly skilled craftsmen with closely guarded secret formulas rendered dyeing a well-protected trade.

The formation of different colours by mixing red, blue, and yellow dyes was well known in ancient times, as was the use of metal salts to aid the retention of dyes on the desired material and to vary the resultant colors. Natural dyes cannot be applied directly to cotton, in contrast to wool and silk, although cotton can be dyed by vatting or by pretreatment with mordants.

The term mordant (sometimes called a fixative) comes from the Latin word mordere which means to bite. A mordant is an element that quickens the chemical reaction taking place between say a natural dye and the fiber. It helps in the dye to get absorbed. A mordant combines with the dye and "bites into" the dye material, enters deeply into the fiber, and when the dye is added, they combine to form a color; since the mordant is thoroughly embedded, so is the color. Sound a bit complex? In answer to the question, "What does a mordant do?" We can think of it this way. The mordant is a translator that speaks both the language of the fiber and the language of the dye. It functions like a chemical bridge, binding to both the dye and the fiber more effectively than either can bind to the other.

Different fibers also have different tendencies to absorb natural and synthetic dyes. Mordants for protein fibers, like wool and silk, are usually applied in acidic dyebaths. Alum with the assistance of cream of tartar, is the most common mordant used to assist the dyes in taking to the fibers, citric acid and vinegar (acidic compound in white distilled vinegar is acetic acid) are also often used.

Mordants essentially open up the fibers and allow the dye to cut into the fibers, giving it permanence. It enriches the color and prevents dye colors from fading with washing or in contact with light. Some dyestuffs are not able to penetrate the wool enough to keep from washing or fading away—unless a mordant is used.

It's tempting to assume that using more mordant will yield darker or brighter colors, but this is a false assumption. In fact, higher doses can harm the fibers and end up greatly shortening the useful lifespan of your fibers, or outright ruin them! All without any change in the color. It's important to pay close attention to the time, concentration, and temperature for every recipe you use. Those are the principal variables that control any chemical reaction.

Mordanting your fibers before they enter the dye vat is known as premordanting. It can be done right before you dye the fibers or they can be left to sit indefinitely before they enter the dye vat. Some dyers say the best results come when you let them sit for about a week before you dye them.

Alum: Also known by a much longer name of potassium aluminum sulfate, alum was likely discovered during Roman times and later used in natural dye houses. Alum is commonly used in municipal water treatment systems to remove heavy metals, and coagulate (thicken) solid waste, in small amounts for making pickles, and as an ingredient in baking soda.

Due to its relatively benign nature of alum and the accuracy of color alum is the most often recommended mordant for most recipes. *Most alum sold for natural dyes is named potassium aluminum sulfate, yet sometimes aluminum sulfate is labeled as alum. Be aware that aluminum sulfate can include traces of minerals such as iron, which will give you VERY different colors in a dye vat.*

Afterbaths:

Afterbaths are useful for expanding the range of color from a single dye vat. Fibers and fibers can be immersed in the after-baths directly or immediately or soon after they are removed from your dye pot. Preparing the baths is very simple and students will be amazed that the results are so immediate!

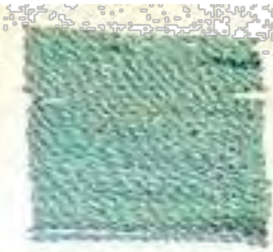
Vinegar: A vinegar after-bath will brighten up your orange, red, and yellow dyes. Fill a glass, stainless steel, or enamel vessel with enough tap water for your fibers to swim freely. Add approximately 1/2 cup of vinegar for every 4oz of fiber you are dipping. As an alternative you can begin with cold water and heat your vessel on the stove until it is hot to the touch. Add vinegar once the water is hot. Transfer fibers to your vinegar solution immediately after removing them from the dye vat. Stir gently and continuously in the solution for up to 10 minutes.

Have students try other mordants on the fibers students have dyed and see what changes in the colors. Try after baths and see what color effects they have. *See samples of what a* *difference mordants can make on the next pages.*

Have students test the dyeing techniques on different fabrics and fibers: ex. cotton, linen, and wool. What happens? *See samples of what a difference mordants & materials can make on the next pages.*

Yellow onion skins with alum mordant on wool

Alkanet roots with no mordant on wool



Elderberries with chrome mordant on wool

Indigo with alum mordant on wool (Method No. 1)

Indigo with alum mordant on sisal (Method No. 1)

Indigo with alum mordant on cotton (Method No. 1)

Indigo with alum mordant on wool (Method No. 2)

Logwood with no mordant on wool

Logwood with copperas mordant on wool

Annatto with alum mordant on wool

Bloodroot with no mordant on wool

Bloodroot with alum mordant on wool

Gum catechu, no mordant on wool

Henna with tin mordant on wool

Henna with tin mordant on mohair

Lily of the valley with chrome mordant on wool

Madder and sedge with alum mordant on wool

Pokeweed berries with chrome mordant on wool

Burley tobacco with blue vitriol mordant on wool

Cocklebur with copperas mordant on wool

Goldenrod blossoms with copperas mordant on wool

Goldenrod blossoms, indigo, alum mordant on wool

Goldenrod plant, copperas mordant on wool

Gum catechu, blue vitriol mordant on wool No. 1

Cochineal with alum mordant on wool
Cochineal with alum mordant on linen
Cochineal with tin mordant on wool
Cochineal with tin mordant on silk
Cochineal with tin mordant on cotton
Cudbear with alum mordant on wool
Cudbear with alum mordant on jute
Lavender, mace, rosemary, alum mordant on wool
Madder (powder) with alum mordant on wool
Madder (powder) with tin mordant on wool
Madder (roots) with alum mordant on jute
Pokeweed berries with alum mordant on wool
Scarlet Sage blossoms, alum mordant on wool
Annatto, red onion skins, tin mordant on wool
Dandelion blossoms, alum mordant on wool
Goldenrod blossoms, alum mordant on wool
Goldenrod blossoms, chrome mordant on wool
Goldenrod blossoms, tin mordant on wool
Lily of the valley with tin mordant on wool
Peach leaves with alum mordant on wool
Queen Anne's lace with alum mordant on silk
Red onion skins with chrome mordant on wool
Safflower with copperas mordant on wool
Sedge with chrome

Natural Dye Chart

Black

A "non-color" color

Go back to the dyes, do we have any shades of back? Have students try to create black without using any of the actual color black (layering dyes and other techniques) and present the following information to students.

Just as white light contains all the colors, black can incorporate the spectrum too. Even the "non-colors", black and brown have rich stories and histories. Of how black dye used to be sold by retired pirates in the Caribbean, how "pencil lead" used to be so rare that armed security guards in northern England used to strip-search miners as they left after a long day underground and people risked their lives to find it and steal it (Parliament even passed a law decreeing anyone in possession of illegal graphite could be punished with a year's hard forced labor or deportation to the colonies), how white was a tantalizingly sweet and deadly poison, and how black and brown paints were once said to be made from dead bodies.

It was the theory that "black" happens when an object is absorbing all the colored wavelengths which led many painters (especially the Impressionists) to not use black pigments at all, instead they used mixtures of red, yellow, and blue. "There is no black in nature" was the popular refrain of the Impressionists. If you look closely at Claude Monet's *Gare Saint-Lazare*, for example, the pitch dark trains are actually made up of vivid reds, blue, and emerald greens.

Waspy Woman

The female *Cynips quercus folii* is notable for her unusual nest making—puncturing a home for her eggs in the soft young buds of an oak tree. The tree quite naturally protests the invasion and forms little nutlike growths around the wasp holes, and it is these protective oak galls which (when collected before the wasp eggs hatch) form the basis of an strong and acidic black. It was used throughout Europe from Middle Ages, and the process was probably learned from the Arabs, who used it for ink, clothes dyeing, and mascara.

Even today our black inks tend to be made of aniline blues, reds, yellows, and purples, blending together so they absorb most of the light rays that shine on them, and give the impression of being black. If you leave them on a sunny window ledge then the words will quickly fade. Test it out: *Like sunlight, chemical mixtures can also be broken into their component parts. One way of doing this is a simple technique called paper chromatography. What do you think you will see if you use paper chromatography to look at the components of black ink? Is black ink just black? Have students find out for themselves using the included experiment.*

When it comes to dyes, and dying cloth, it's an unbelievably complex issue for dyers throughout history. What's the issue? The problem is that there are no true black dyes. There are black pigments—charcoal, soot—but pigments don't usually dissolve (soluble) in water, so it's hard to get them to fix onto fabric. What many people have done throughout history is dye clothes in several vats of blue, red, and yellow, until the impression was one of blackness, but that is really expensive. Other options had to be found.

In Western culture black often represents death. Blackness is after all a description of what happens when all light is absorbed and nothing is reflected back, and it's often seen as a sign of seriousness. When 16th century Venetians were seen as too frivolous a law was passed that all gondolas should be painted black, to signify the end of the party. As such, black was adopted enthusiastically by the Puritans (if they did anything enthusiastically) a group of people who were considered very serious and strict people who didn't believe in frivolity and wanted to change things in their Church. They were religious protestors and they wanted black clothes, lots of them, quickly! The market (and technology) weren't ready for the rush, making serious problems for dyers. Many black clothes were dyed with oak galls fixed with alum, but the color tended to fade quickly and to eat into the fabric. Other recipes included plants and nutshells—alder, blackberry, walnuts, and others—but these tended towards gray, not black.

It's particularly ironic that the clothes of the most puritanical of the Puritans were often made with a color collected by rough retired pirates and paid for by exchange for rum liquor and enough cash to keep some very disreputable businesses very busy and literally, “in the black.” When piracy was suppressed in 1667 it had the effect of making the seas safer, but it also put a lot of buccaneers out of work “who would murder their own brothers if the return was good enough.”

What kind of treasures do students think that pirates might be looking for? "…a shipload of treasure? Diamonds and rubies and gold beyond measure…?" What do we normally think of when we think about pirate treasure? If they were pirates who had run out of business and money what treasure would they look for? Jump aboard the Lady Luck, the fastest ship on the seas! Join her ragtag crew of pirates, or infiltrate their ranks, working undercover for the police.

I was sailing along and what did I see? An island of GOLD in the scurvy sea! But there’s one small thing I forgot to share —
there’s also a MONSTER waiting there.

What might the pirate ship rules be? ex: "Finders keepers, losers weepers." Have students write about their treasure hunt. A fun book related to this topic may be *The Pirate Cruncher* by Jonny Duddle or Melinda Long's *How I Became a Pirate*.

What was the real treasure they were after? One of the best get-rich-quick schemes of the day was collecting logwood—the newly trendy black dye, much in demand in Europe. These wild pirates moved to the border of what is now Mexico and Belize and lived in the mango swamps harvesting logwood.

Logwood dye, to last more than a few days in the sunshine, the crushed logwood needed to be overdyed on top of woad or indigo previously dyed fabric. The way to prove this was usually to leave a little triangle of blue somewhere on the cloth, to show the indigo blue that lay underneath. But sometimes lazy (and money grubbing) dyers would just dip a corner into indigo and leave the rest undyed. What did that mean for the poor Puritans? The black fabric they had presumably bought in good faith would fade to orange within weeks. And they would know they had been cheated, and they were stuck with orange.

So black can be made of soot and galls, peach stones, vine twigs, or even ivory, but one of the more notorious ingredients in the 17th century was bone black, which was rumored to come from human corpses. In truth, bone black—a rich blue/black pigment—was usually derived from burning the thigh bones of cattle or the limbs of lambs until they became charcoal: scraps from the slaughterhouse’s remainder pit. And in fact it was not black which was sometimes made from dead human beings. It was brown.

Bone Black

Soot

Brown

Another "non-color" color

Have students work to create brown dyed fibers.

Brown has an odd place in the hierarchy of colors. It's certainly a color, but, rather like pink, it has no easy place in the spectrum.

Brown has been such an abused color, especially when it comes to names. There are terms like drab, which was once a technical term for a color straddling the line between olive and puce, but is now a term for dull and uninteresting. Even puce (now a dark purplish-brown), which technically means "flea colored" was once a compliment for Marie Antoinette's (the last Queen of France) favorite color. (The color was actually named by her husband – King Louis XVI. In an effort to control his wife's wild spending the Dauphin labeled the latest dull color fad as *puce*, or flea, hoping that it will turn his queen off. Not only did it not dissuade Marie Antoinette about the color's charm and appeal but the Dauphin himself sported the color towards the end of his life.)

Marie invented and named many colors, with a boundless appetite for anything new! This hunger drove her to request brand-new, of-the-moment colors that often did not exist. She invented colors that were inspired by the most unexpected of sources such as a dull greenish brown, *caca du dauphin*, named after her newborn baby boy's soiled swaddling clothes (dirty diapers), which was later very popular in the 1930s.

Even browns with lovelier names have histories based in decay and bad smells, such as the color “Isabella” which was named after Queen Isabella of Spain who made the unusual pledge to not change her bodice until a particular town was liberated. Unfortunately, it wasn’t liberated for six months or more! **What happens to a white shirt if you leave it on too long? What color does it turn?**

After the 18th century brown ink was often made from sepia, the dark liquid given off by cuttlefish when they get scared, but traditionally, most browns come from the earth and materials like umber and sienna. But the most extraordinary brown was called mommia or “mummy,” and it was, as its name promised made up of dead Ancient Egyptians. They would visit mass graves of mummies and collect parts (heads, hands, arms, feet) to be ground up and used to make a thick paint that was apparently excellent for shading, but no good as a watercolor. If the suppliers ran out of “Egyptian brown” they would sometimes make their own from rather fresher corpses. According to one recipe you could take a freshly deceased young man (red haired was recommended) who had been killed (but not by a disease) soak it in water, then wine and turpentine, and it would make as good a brown as the ancient mummies.

Umber

Cuttlefish (Sepia)

White

White paint can be made of many things. It can come from chalk or zinc, barium or rice, or from little fossilized sea creatures in limestone graves. The greatest of whites, and the cruelest, is made of lead. European artists for hundreds of years have rated lead white as one of the most important colors on the palette, beloved for its shine. Some have called lead white the most important pigment in the history of Western painting.

White paint is white because it reflects most light rays away from it. The penalty it pays for this apparent purity is that it absorbs almost no light into its own body, and—for lead white at least—its own heart is black, and by that we mean poisonous, in fact, deadly. In its time lead paint has poisoned artists and factory workers, women looking for beauty fixes and even tiny children playing on slides, attracted to the strange sweet taste. The poison came as no surprise, its deadly allure has been written about since Roman times, but somehow nobody has seemed to care about the consequences too much.

The modern formula to make it is nearly the same as the one used by the ancients. Acid + metal = paint In fact the most radical recipe change was introduced in Rembrandts time, which included a new and nasty ingredient. The Dutch process involved using clay pots divided into two sections, on for lead and one for vinegar. The apprentices would line up several dozens of these and then they would add the final ingredient, great bucketsful of manure straight from the farm, which would be heaped all around the pots to make not only heat to evaporate acid but the carbon dioxide to transform the substance from lead acetate to basic lead carbonate. The room would be sealed, and was left closed for 3 months/90 days, after which the apprentices would have to open the door. In those three months the stagnant heat, decomposing manure, sour wine, and poisonous metal magically transformed. Dirt and smells metamorphosing into the purest and cleanest white, like little grains of sugar.

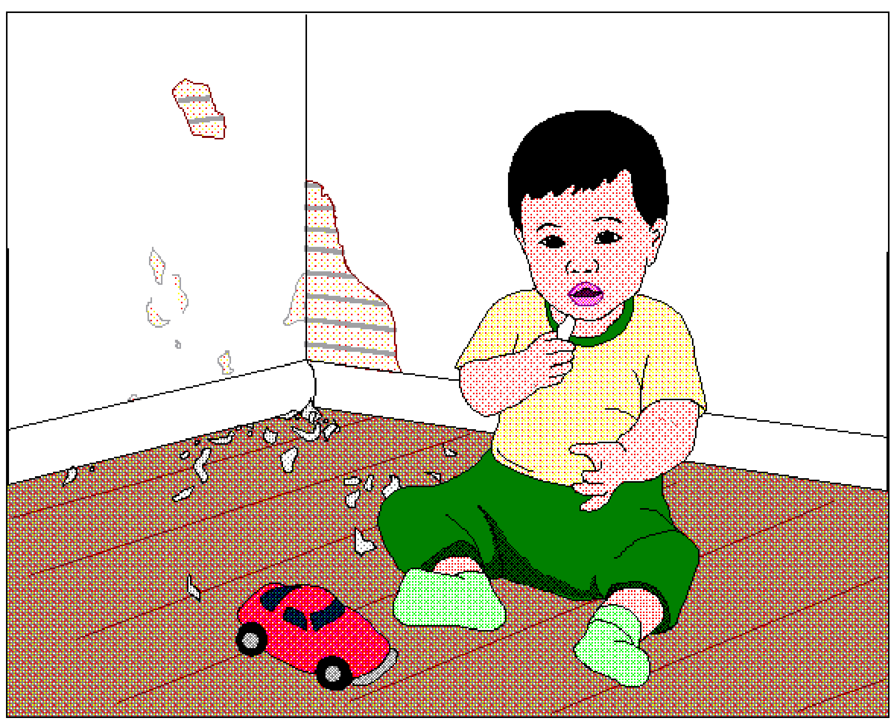
Dying to be White

Lead white was rarely more insidious than when it was used for makeup, for beauty. In the 1800s it was sold as "Bloom of Youth" women applied it diligently to their faces, and died of lead poisoning. This was hardly the first time. Lead has been used in face creams and makeup since Egyptian times, the Roman women swore by it, Japanese geishas used it, but even in the 1800s, when the dangers were more understood, it was common on the dressing tables of women of every complexion. One of the problems was that in the beginning it would make its victim feel more attractive. Lead exposure made women seem like ethereal spirits or angels with pale clear skin. By the time the truth was clear, it was too late.

Lead is not only poisonous; it is also—when suspended in water based media—not even particularly stable. For in the course of time, it turns black.

If white lead did so much damage, why did so many artists use it? The simple answer is there was very little else. There was bone white (from burned lambs bones) but artists found it gritty and gray. Then there were the shell paints, made of seashells, eggshells, oysters, chalk, and even pearls, or chalky whites. The disadvantages were they didn't have the texture and shine of lead.

Get the Lead OUT! Lead Poisoning Today



Lead poisoning continues to be a danger today and has been referred to as the "silent epidemic." Rarely are there visible symptoms. A child may not look or act sick. Lead poisoning is our nation's number one childhood environmental health problem. When lead accumulates within a child's body it affects that child's normal growth and impacts upon his health, behavior and intellectual development. The only sure way to determine whether a child has a high blood lead level is to have that child tested annually for lead poisoning. This is

particularly true for those children living in older homes where the risk of lead poisoning is greater.
The effects of lead poisoning depend on how much lead has been absorbed into the body and the duration of the exposure to lead. Symptoms are often hard to detect and may lie dormant for many years. To make matters worse, lead is passed from generation to generation: lead, like calcium, is actively drawn out of a pregnant woman's body by the placenta and delivered in concentrated form to a developing fetus.

In the majority of lead poisoning cases there may be no warning signs or signs may be as common as fatigue, loss of appetite, irritability, sleeping problems, or sudden behavioral changes. More serious indications include pica (the eating of non-edible items), clumsiness or loss of muscle control, weakness, abdominal pain, vomiting, constipation and changes in consciousness. In severe cases, coma and death can occur.

A child poisoned at two years might be more likely to drop out of high school or have a lower IQ than his contemporaries. After the United States removed lead from gasoline in the 1970s and 1980s, the average IQ score rose around 10 points.

How do we get exposed?

There are three primary sources of lead in the environment. These are: paint, dust and soil.

Young children often place their toys, fingers, and other objects in their mouth as part of their normal development. This hand-to-mouth activity may put them in contact with lead paint or dust.

The most common sources of lead exposure for children are chips and particles of old lead paint. Although children may be directly exposed to lead from paint by swallowing paint chips, they are more commonly exposed by swallowing house dust or soil contaminated by leaded paint. This happens because lead paint chips become ground into tiny bits that become part of the dust and soil in and around homes. This usually occurs when leaded paint becomes old or worn or is subject to constant rubbing (as on doors and windowsills and wells). In addition, lead can be scattered when paint is disturbed during destruction, remodeling, paint removal, or preparation of painted surfaces for repainting.

Lead, which is invisible to the naked eye and has no smell, may be found in other sources. These sources may be the exposure source for as many as 30% of lead-poisoned children in certain areas across the United States. They include:

- traditional home health remedies such as azarcon and greta, which are used for upset stomach or indigestion in the Hispanic community
- imported candies
- imported toys and toy jewelry
- imported cosmetics
- drinking water contaminated by lead leaching from lead pipes, solder, brass fixtures, or valves and
- consumer products, including tea kettles and vinyl mini-blinds
- Pottery and ceramics: Thousands of Mexican potters have been unwittingly poisoning their families and customers with toxic lead for 400 years by using lead-based ceramic glazes which lend a lustrous glow to pots, cups and plates.

> A team of U.S. and Mexican health and other experts has now launched the first skirmish in a war on lead: 100 pottery-making families have replaced the lead glaze with lead-free glazes newly created by Mexican researchers. It is not only healthier, it also good business to get rid of lead - the non-lead glaze was more appealing in color and appearance than lead glazes when shown to shoppers. But tens of thousands of potters are still reluctant to change their old ways and many continue to use lead, saying: "It was good enough for our ancestors so it should be good enough for us."

Additionally, a variety of work and hobby activities and products expose adults to lead. This also can result in lead exposure for their families. Activities that are associated with lead exposure include indoor firing range use, home repairs and remodeling, and pottery making. "Take-home" exposures may result when people whose jobs expose them to lead wear their work clothes home or wash them with the family laundry. It also may result when they bring scrap or waste material home from work.

Protecting Children from Lead Exposure

Lead poisoning is entirely preventable. The key is stopping children from coming into contact with lead and treating children who have been poisoned by lead.

The goal is to prevent lead exposure to children before they are harmed. There are many ways parents can reduce a child's exposure to lead. The key is stopping children from coming into contact with lead. Lead hazards in a child's environment must be identified and controlled or removed safely.

Bone White

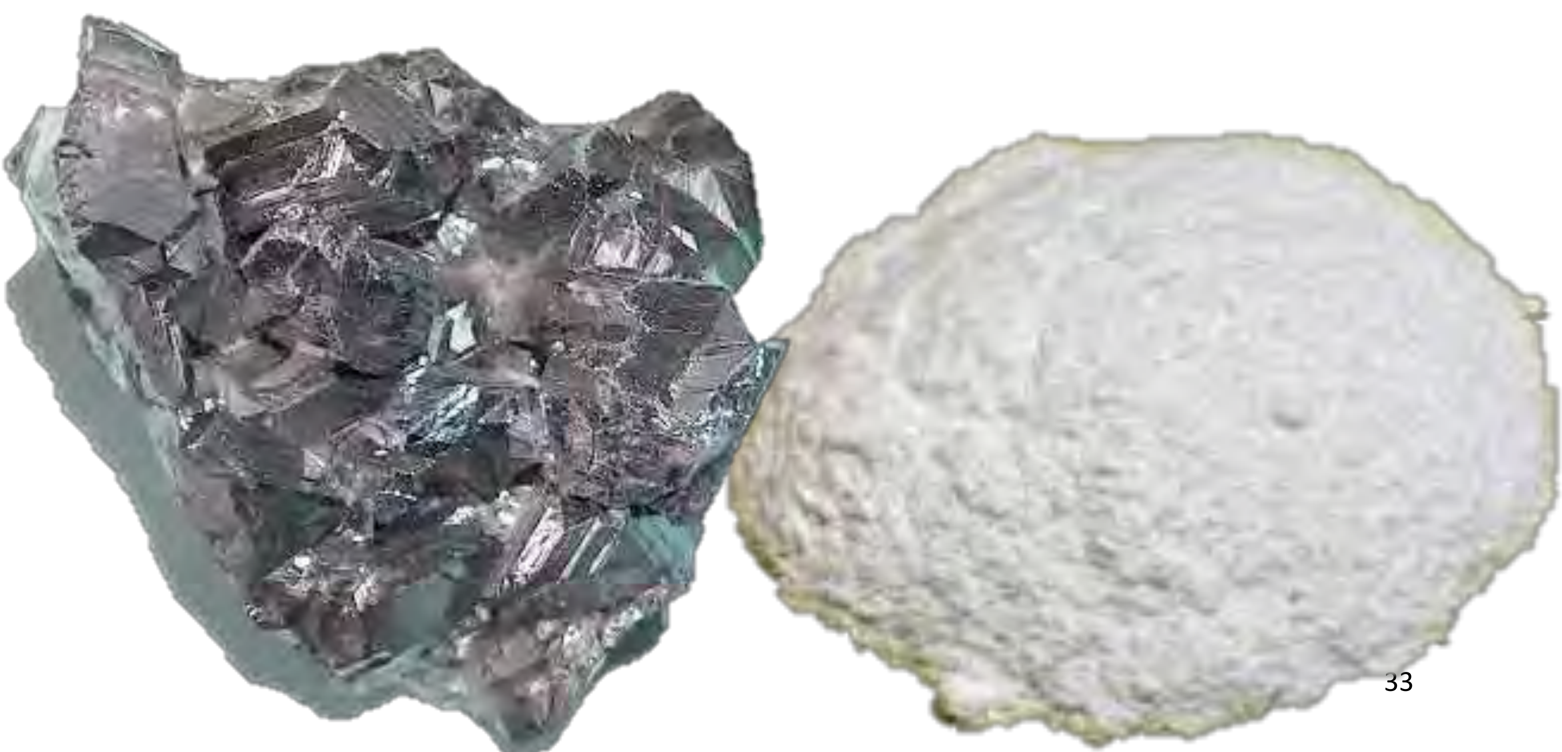
Eggshells

Oyster Shells

Barium

Rice

Limestone



Zinc

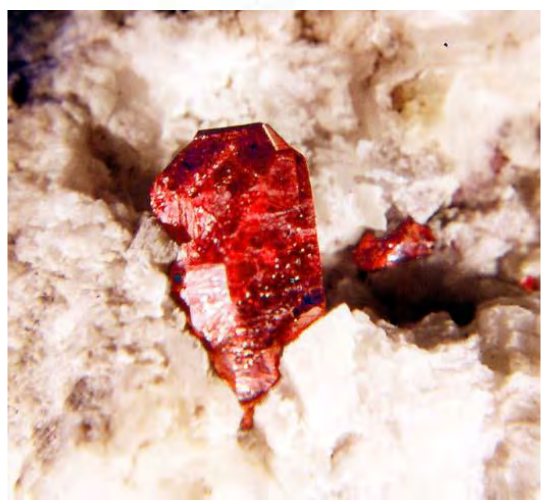
Chalk

Lead

Red

For many cultures red is both death and life—a beautiful and terrible paradox. In our modern language of metaphors, red is anger, it is fire, there are songs about, it is the wild emotions of the heart, it is love, it is war, and it is power.

Cinnabar



A popular red, cinnabar, which in its manufactured form is named vermilion, was born, according to Pliny, from an epic struggle between an elephant and a dragon. Apparently these two troublemakers were always fighting, and the battle eventually ended with the dragon—evidently with a long and snake-like body—wrapping itself around its heavy and elephantine enemy. But, as the elephant fell it crushed the dragon with its weight and they both died. The merging of their blood made cinnabar. This is a marvelous metaphor for the true origin of this expensive hue, which is made from heavy mercury (elephant) and burning sulphur (dragon). Its chemical designation is HgS which means that the two chemicals, like the two combatants, are equally matched. Combined the silver elephant and the fire breathing reptile make something that is blood red.

The Romans loved cinnabar. They painted their heroes with it; rich women sacrificed healt for beauty and made it into lipstick, and it was used to paint the statues of the gods and the emperors on festival days. The Romans got their vermilion from the greatest mercury mine in the classical world, Almaden, located about 200 kilometers south of Madrid, in Spain. Two thousand years later it is still the world's most productive mercury mine.

In the 16th century there were famously a choice of two punishments for prisoners: the galleys or Almaden. A lucky man got sent to the prison ships to serve as a slave. Just a couple of years mining for red—twelve hours a day with no protection and no air conditioning—would fill a prisoner's body with so much heavy metal they would die a terrible death. The prisoners were forced to work bent over in the tunnels for so long they became unable to straighten up.

For color users around the world, the search for the perfect red—with all the risks that it has sometimes involved—has never really ended.

What is mercury anyway, and what's so dangerous about this naturally-occurring element? Aren't natural things good?

Mercury, also called quicksilver, is the only common metal which is a liquid at room temperature. Heavy and silvery-white in appearance, mercury rarely occurs free in nature, and is found mainly in cinnabar ore from Spain and Italy. The metal is extracted by heating cinnabar (the combination of mercury and sulphur that the Romans loved) in a current of air and condensing (concentrating) the vapor.

Mercury is a poor conductor of heat as compared with other metals, but it is a fair conductor of electricity. It is so heavy and dense that objects such as bricks, cannonballs, and lumps of lead will float on its surface.

Cannonball in mercury

Mercury easily forms alloys (combinations) with many metals, such as gold, silver, and tin and as such, has been used to make amalgams (combinations of metals) since 500 BC. In addition, the ancient Greeks used mercury in ointments (medicinal lotions) and the Romans used it in cosmetics (make-up). The expression “mad as a hatter" is said to have referred to hatters who suffered brain damage as a result of the use of mercury in felt hat-making; mercury nitrate aided the removal of fur from animal skins.

Today, mercury is used for the manufacture of industrial chemicals and for electrical and electronic applications. It can be found in meteorological equipment like thermometers and barometers. Why? Because mercury is the only liquid metal and liquids expand more than solids on heating.

Mercury is one of the few elemental substances that is liquid at room temperature, most of them are solids. Like all substances, mercury expands as temperature increases. Coupling these two properties, a thermometer is formed. By confining the mercury to a container of known dimensions, we can determine the ambient temperature based on how much volume the same amount of mercury occupies. Because mercury expands very little relative to daily temperature changes, the cross section of thermometers must be small enough to be able to show this change in volume.

Gaseous mercury is used in mercury-vapor lamps which light highways at night. Mercury batteries, metals used in dental work, and even mirrors can make use of mercury.

But although mercury has such widespread use, it has long been known to be highly toxic in both liquid and gaseous forms, causing brain and/or liver damage if ingested, or with prolonged exposure. In its pure metal form, mercury is not deadly, but in compounds such as mercuric chloride, it is lethal. Many organic mercury compounds are also quite important — and quite dangerous.

Among the most lethal of these is methylmercury, a pollutant found in rivers and lakes and fish. Nearly all fish contain trace amounts of methylmercury. How does this element get into our fish supply? Mercury occurs both naturally and from man-made sources. Some of it can be traced to coal-burning power plants. Smokestacks release toxic mercury emissions which rain down into rivers, lakes, and oceans. Bacteria convert the mercury to a form that's easily absorbed by insects and other small organisms. Mercury moves up the food chain as small fish eat the small organisms and big fish eat the smaller fish. The highest concentrations accumulate in large predators such as shark, swordfish and tuna...some of America's favorite fish.

Until the 1950's, the problems that can occur with excessive mercury intake were not well-known. However, at that time, an epidemic hit fishermen and their families in villages on Japan's Minamata Bay. People whose diet was primarily seafood showed signs of brain damage; some were even fatally stricken with disease and seizures. The investigation linked the health problems to methylmercury poisoning from a local chemical plant that was discharging organic mercury into the bay. The villagers were getting sick from eating the fish that had absorbed the mercury.

In America one-in-six children born every year have been exposed to mercury levels so high that they are potentially at risk for learning disabilities and motor skill impairment and short-term memory loss. That type of mercury exposure is caused by eating certain kinds of fish, which contain high levels of the toxin from both natural and man-made sources such as emissions from coal-fired power plants. One government analysis shows that 630,000 children each year are exposed to potentially unsafe mercury levels in the womb.

Tuna, widely known for its health benefits, is one of the most popular foods on grocery store shelves. In 1969, the FDA first set an allowable level for total mercury in fish; 0.5ppm (part-per-million) was considered the maximum safe limit. (Action levels represent the limit at or above which FDA will take legal action to remove a product from the market, in other words, make the producer recall it.) In 1979, the action level was raised to 1ppm. In 1984, there was another major change. The FDA stopped measuring on a basis of total mercury and instead started checking levels in terms of methylmercury only. In 1998, the FDA stopped widely testing for mercury in fish at all. However, in 2000, FDA draft advisories presented to focus groups warned women not to eat a lot of canned tuna during pregnancy because it contains levels of mercury that can harm developing fetuses and nursing babies.

Around the world, there is concern about mercury contamination through fish, but specific recommendations vary. For example, Health Canada advises consumers to limit their consumption of swordfish, shark or fresh and frozen tuna to one meal per week; for young children and women of child-bearing age, the recommended limit is one meal per month. Health Canada's guideline is 0.5ppm total mercury content — more stringent than in the U.S. Britain's Food Standards Agency is advising pregnant and breastfeeding women and women who intend to become pregnant to limit their consumption of tuna to no more than two medium-size cans or one fresh tuna steak per week.

Even within the United States, we hear different advice from different sources, especially where tuna is concerned. The EPA's methylmercury guideline is a recommended limit on mercury consumption based on bodyweight, also known as a "reference dose." EPA's methylmercury reference dose is .1 micrograms/kg body weight per day. In July 2000, the National Academy of Sciences found the EPA's reference dose as "scientifically justifiable" for protecting most Americans.

So exactly how much mercury a 45 lb. child would ingest by eating one 6 ounce can of tuna per week, and how does that compare to the EPA's reference dose? **Have students do the following calculations either as a group or as individuals or in pairs:**

Step 1 - DETERMINE EPA's RECOMMENDED LEVEL FOR A 45 LB CHILD

- Multiply child's body weight by EPA's reference dose.
- Convert 45 pounds to kilograms = 20.45 kilograms
- 20.45 kilograms x .1 micrograms per kilogram per day

EPA RECOMMENDED LEVEL = 2.05 micrograms per day = 14.35 micrograms per week.

Step 2 - HOW MUCH MERCURY IS IN 6 OUNCES OF CHUNK WHITE TUNA?

- Multiply amount of fish by average mercury level for chunk white albacore.
- Convert 6 ounces to grams = 170 grams 170 grams X .31 ppm (or micrograms per gram)**

MERCURY INGESTED = 52.7 micrograms per gram

Step 3 – COMPARE MERCURY INGESTED WITH EPA'S RECOMMENDED LEVEL

- Divide 52.7 micrograms by 14.35 micrograms = 3.7

Results: By eating just 6 ounces of chunk white tuna a week, the child is ingesting almost four times EPA's recommended dose.

Various states have also approved legislation or are considering laws that would prohibit the sale of mercury fever thermometers and establish a thermometer exchange program.

Bug Blood

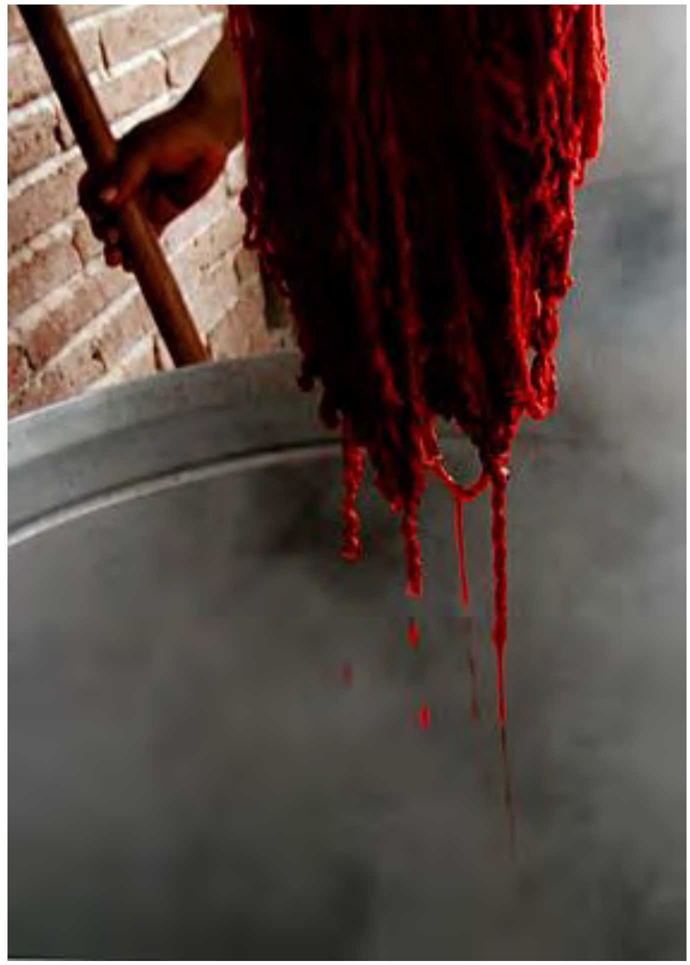
One of the most precious shades of red, carmine, is really made of blood. For centuries it was the treasure of the Incas and the Aztecs. It has been used on the robes of kings and cardinals, on the lips of movie actresses, on the camel bags of nomads, and the canvases of great artists, and it's probably in your refrigerator right now.

Image Credit: ArtbyGavin.com

In the sixteenth century when the Spaniards conquered Mexico they did not find as much gold as they had hoped for in Oaxaca, but they discovered the Aztecs wearing materials dyed bright red and saw highly colorful fabrics from naturally dyed fibers.

Conquistadors + New World = Influx of Insects

At the height of its powers, the Inca Empire controlled 10,000 kilometers/ 6214 miles of roads. In the absence of wheels, horses, or any high speed modern communication devices like phones, they came up with their own. The government ruled with a huge relay team of runners who would sprint for 20 kilometers/12.4 miles. The system was made trickier by the fact that the Inca people had no sophisticated writing system and when the message was too complicated for the messenger of the Inca civil service to remember accurately 12.4 miles later, which was often, he carried his "quipus" or coded cords to pass on the information. Every color and every knot meant something different. A black string represented time, yellow was gold, and blue referred to the sky and—by extension—the gods. But red, deep purple red from the cochineal insect, that represented the Inca themselves, their armies, and their all-powerful emperor. It was life, power and death all bound up in a single piece of string. So, for example, a red cord tied with knots at the top would mean a great battle, and the blood-colored knots would represent how many people had died: vital information for generals preparing to fight their own skirmishes on the boarders of an empire.



The Incas had several reds. They could macerate the wood of the brazil tree to make deep pink, they made orange dye with the dried seeds of the annatto plant, and logwood (which made a better black than red). But the most treasured and precious red was from the cochineal insect. Women used it for blush, potters used it on their wares, it was used on walls and frescoes, but most of all it was used in textiles (fibers and fabrics).

Without any additives the precious dye fades with the first wash. To make the color fix, they used the mordant alum (it is so astringent it bites onto the color and makes it stick to the textile with its metallic teeth), much as colormen have done around the world. At one time this substance was one of the most important chemicals in the world. Without alum you were condemned to a pale and drab wardrobe, and very few ancient fashionistas from the Egyptians onward would have been satisfied with that.

The Spaniards were quick to turn cochineal into an alternative source of wealth and immediately had vast quantities of the dried cochineal insects, from which the dye was obtained, shipped to Spain and other countries. It was more valuable than the gold with which it shared space in galleons returning to Spain! In 1575 alone over 80 metric tons of red arrived in Spain, on what became known as the cochineal fleet. Over the next quarter century the annual shipments sent several trillion insect bodies across the ocean every year.

By 1660, the export of this dye to Europe had become a leading economic earner for New Spain, second only to silver. The government of Spain controlled the trade of cochineal, the red dye from the bodies of the cochineal bugs of Central America.

Fashion changes fast and Europeans were quickly demanding that their clothes be made in the new deep red. It was in everything, not just as a dye, or paint, but also as a medicine. The physicians were flexible, it was deemed perfect for everything from cleaning the teeth, ointment for wounds, and to relieve ailments of the head, heart, and stomach. Not only was it good for the innards, but women were going crazy for the ultimate cosmetic, bug blood. But they didn't know it was bug blood.

Many thought it was from a fruit, a nut, or anything but a bug! Sixteenth century Europeans were desperate to know where the new fabulous dyes were coming from but the Spanish weren't telling. It was in their best interest to keep the source as secret and as safe as their gold, but they couldn't hold out forever.

A Daring Raid Across the Sea

Finally a 20 year old Frenchman—Nicolas Joseph Thierry de Menonville--made the most daring raid of the 18th century as he traveled alone, with very little money, against the advice of friends and family, but with the blessing of the French government, risking his life, scaling city walls, dealing with bad roads, appalling weather, days without food and the constant dangers of the Spanish king's soldiers and the monsoon season; making an impossible journey to the secret cochineal fields of Central America.

Discovering that red paint was made from white bugs he was thrilled and terrified, for how was he to bring such a delicate creature safely home? It was immensely valuable stuff and he bought several leaves covered in bugs (pretending it was for a medical salve) for a single dollar and boxed them up as safely as he could. But Spanish justice was strict, and if the penalty was death by fire for making a few fake coins, what might they do to the man stealing the ingredients of their most valuable trade? He carefully packed his boxes and started out on the dangerous return journey with authorities almost guessing his trickery and others trying to trick him. It was not an easy journey, it took three months for him to reach home, but he was relieved to find that some of his precious cargo had survived. They rewarded him with his own place in Santo Domingo. It must have seemed ironic, and rather cruel, when he went for a walk one day near his house on Santo Domingo, and found indigenous cochineal.

Nicolas died three years later, when not even thirty years old, a disappointed man. He had not become the hero he had dreamed of becoming, but the cactus garden he had so carefully tended allowed the French cochineal industry to thrive for some years, until synthetic dyes entered the scene. His journey was, in his own mind, a failure, it had not brought him the gold he desired, but his work inspired others to try and introduce cochineal to the Old World. **Do students think his journey was a failure? How many people do students think have thought themselves a failure?**

Cochineal

The cochineal bug is a beetle-like insect and parasite that lives in a symbiotic (break the word down into its parts for a definition, sym = together and biotic = life. Used about organisms (especially of different species) living together but not necessarily in a relationship that's beneficial to each.) fashion with the nopal cacti (or prickly pear), feeding on the abundant sap of the thick round leaves. It has the external appearance of a white velvet-like mold.

Prickly pear is easy to grow in the right conditions—25 degrees Centigrade, little rain—but is tempermental, two degrees more or less and it dies. The leaves propagate themselves: they fall off naturally and their tiny prickles turn into roots. The nopal even waters itself. The wide surface of the leaf is its own water bowl—it draws the dew in the night, and drinks it during the day. If they are left to their own devices the cochineal will kill the plant: the grower's job is to strike the balance between letting the cochineals grow to their maximum size and keeping the cactuses alive. The male, thin ghost-like creatures only live two or three days, using their energy to fly through the air and fertilize. They give the plants a few months break and infest them again.

Of notable interest, only the females have this red pigment, due to the presence of carminic acid; the males only serve to fertilize the females. The cochineal eats from the pinkish fruits of the cactus and the pigment of the plant lodges in their colorful shells. Cochineal bugs are farmed for three months, then collected at ninety days old. The female lays her eggs and then she dies, and the scarlet red color is extracted from her dried body using a hot-water dye extraction process.

Harvesting cochineal is intensive. The human laborers use air compressors to shoot the bugs into buckets while wearing gloves, hoods, and glasses. The protection is necessary. One prickly pear spine in the eye and a worker can go blind, even on the skin it is difficult to remove.

Though there is a dark side to the cochineal industry as vats of live pregnant insects are churned into Color Index Number 4.

This little bug has inspired intense rivalries (a plantation owner once put poison in a consignment of cochineal from Peru. It was cheaper (cochineal grew wild there and labor was cheaper) and the only hope for Chile was if the Peruvian stuff was tainted). If you wonder if its cruel the plantation owners will say, “Only for the cactuses: the insects eat them alive.”

On modern cochineal farms, females are harvested when they are about 90 days old. The insects are carefully brushed from the cacti… and placed into bags. The bags are taken to the production plant and there, the insects are then killed by immersion in hot water or by exposure to sunlight, steam or the heat of an oven. The process of extracting the dye is very similar to that of making tea.

The part of the insect that contains the most carmine is the abdomen that houses the fertilized eggs of the cochineal. Once dried, a process begins whereby the abdomens and fertilized eggs are separated from the rest of the anatomical parts. These are then ground into a powder and cooked to extract the maximum amount of color. This cooked solution is filtered and put through special processes that cause all carmine particles to precipitate to the bottom of the cooking container. The liquid is removed and the bottom of the container is left with pure carmine. and then combined with either alum or another mordant which acts as a fixer. The resulting distinctive tones can range from red to purple depending on the acidity or the alkalinity of the mixture.

Research indicates it can take up to 70,000 crushed insects to produce about a pound of cochineal dye powder, which can then be used to dye fiber, fabric, and other materials. Workers also combine this little bug-dye with plants dyes to get even more tones. It's even used today for both fabric production and in a variety of foods and drinks you may eat on a regular basis!

In 1587 approximately 65 tons were shipped to Spain, and from there northward throughout Europe (Grierson, 10). Unusually versatile, cochineal can adopt shades from orange to violet, according to the mordents, fixatives and toners applied. Its effect on wool and silk - both protein fibers - can be spectacular.

Carmine—or cochineal or crimson, it has many names—is one of the reddest dyes that the natural world has ever produced. The words Cochineal, Cochineal Extract, Carmine, Crimson Lake, Natural Red 4, C.I. 75470, E120, and even some 'natural colorings' refer to this dye, making it harder to tell. It's used in is used in a wide variety of products, including some meat, sausages, processed poultry products, marinades, bakery products and toppings, cookies, desserts, icings, pie fillings, jams, preserves, gelatin desserts, juice beverages, some cheese and other dairy products, sauces, and sweets. Women today around the world coat their lips with insect blood, dab their cheeks with it, rub it in our scalps and skin, and spread it on our lids, Starbucks had it in their Strawberry Frappuccino, and Cherry Coke is full of it, as color additive E120.

According to one distributor of carmine, the product can be used in the following ways:

- **Food Industry** – Frozen fish (ex. imitation crab meat), meat, sausages, marinades, etc.
- **Beverage Industry** – Soft drinks, fruit drinks, energy drinks, etc.
- **Alcoholic Beverages** – Products with low pH requiring red or orange tones
- **Dairy Industry** – Yogurts, ice cream and dairy based beverages
- **Confections** – Candy, fillings, syrups, gelatins, chewing gum, etc.

FYI: Seeing Red

Long ago, during the 1950's, the farmers realized that chickens raised under red lights tended to be less aggressive and, as a result, consumed less food. An added bonus was that they produced more eggs. This meant larger profits for the farm owner. Unfortunately, the workers couldn't see what they were doing under the red lights, so an alternative approach was needed.

Someone then came up with the bright idea of putting red glasses on the birds. You know - cool shades. But, you can see the problem with this method - the glasses fell right off the chicken's head. Plop!

A company* that marketed red contact lenses for chickens (at 20 cents a pair), points to medical studies showing that chickens wearing red-tinted contact lenses behave differently from birds that don't. They eat less, produce more eggs, and don't fight as much. This decreases aggressive tendencies and birds are less likely to peck at each other causing injury. A spokesman said the lenses could improve world egg-laying productivity by $600 million a year.

When they hit the market in 1989, the lenses sold for 20 cents per pair, or 15 cents if bought in bulk.

Fitting a bird with these lenses is quite simple - you hold the bird's head steady for a few in seconds and insert the lenses.They are supposed to stay for life. Unfortunately, no one told the chickens that.

Many of the lenses fell out and the product continues to undergo modification and further testing.

* Animalens Inc. of Wellesley, Mass

If you don't believe this, read the facts!
http://www.inc.com/magazine/19890501/5636.html

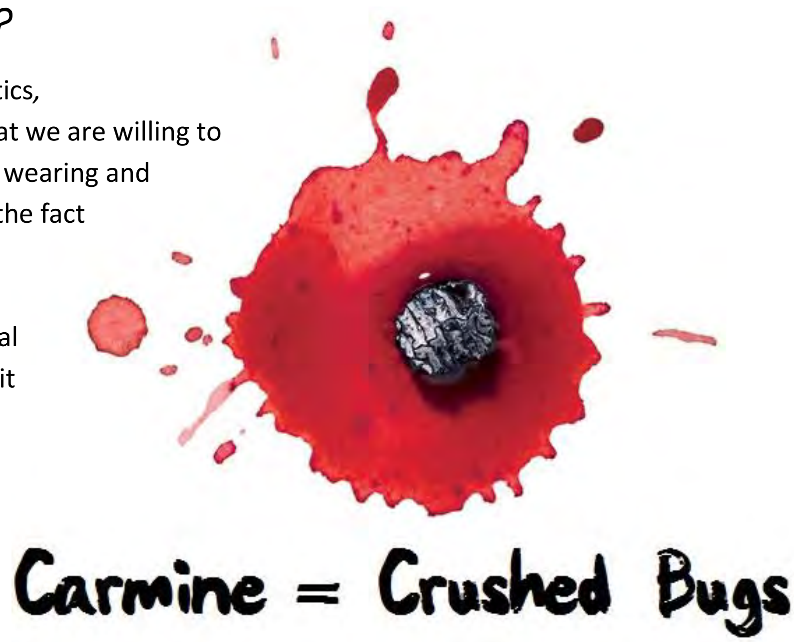
- **Fruit Preparations** – Canned fruits such as cherries, jams, pie filling, pulp, juices, etc.
- **Cosmetic Industry** – blush, eye shadows, lipsticks, etc. And it is 't just red shades of make-up- carmine is also used when developing many other colors such as shades of pinks, corals and purples. It is also an ingredient in many make up items that have no red pigment what so ever
- **Others** – Ketchup, powdered drinks, dehydrated soups, canned soups, etc.

Carmine is also used in the manufacture of artificial flowers, paints and crimson ink. **Show students some products, can they find any of the names for carmine?**

As of January 5, 2011, the ingredient must be included on packaging labels when used as a food additive, as it has been known to cause severe allergic reactions, asthmatic attacks, and anaphylactic shock in some people. However, as health fears over artificial food additives have increased, cochineal dyes are regaining popularity, making the insect profitable again. As of 2005, Peru (the largest exporter) produced 200 tons of cochineal dye per year and the Canary Islands produced 20 tons per year. Chile and Mexico have also recently begun to export cochineal once again.

Debate It! Better or Worse?

Some people say: "Is red coloring in food, cosmetics, pharmaceuticals and fabric so important to us that we are willing to turn a blind eye to its origin? Why? If the idea of wearing and eating dead bugs doesn't gross you out, think of the fact that millions of beetles have died unnecessarily. Don't care about beetles? Ask yourself why. Are they not cute enough? Do they not have individual personalities? Does it even matter? What makes it ok for us to pluck thousands of little bugs, boil them alive and use them in our make-up and food? Who gave us the right to do that? Is it because we are bigger, smarter, more civilised? Is it civilised to crush the life out of another living creature? Yeah, I don't think so."

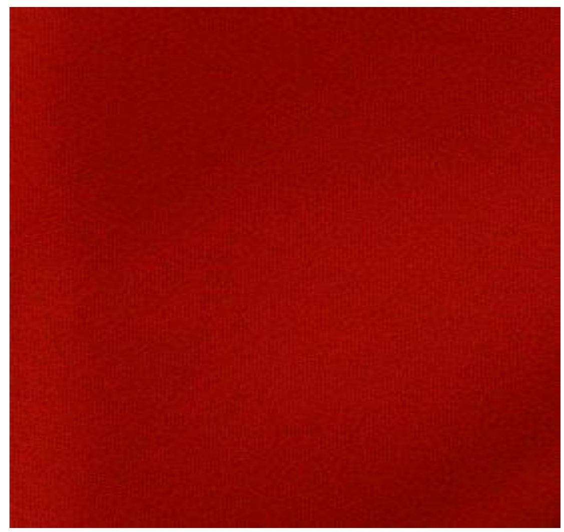


Others say: "Some of you might be thinking "Whoa... we eat bugs" and the answer is "yes". I'd much rather know my food's added color comes from a bug than a chemical. You've swallowed a spider or two in your sleep, you'll be fine. The products in question are treats, not staples of nourishment like rice and wheat but indulgences. I'm all for people honoring a lifestyle or religion, but with that comes sacrifices like the omission processed food. All processed food has "mystery bits", it's just part of the process (they allow for it). If you don't like the product don't order it, walk down the street and visit a smaller business that uses fresh ingredients. Would you rather that instead of cochineal dye companies start using some industrial petrochemical product, the manufacture of which causes massive habitat destruction, wiping out not just individual insects but possibly entire species of all kinds of organisms?"

What do your students say? Is the origin of the color problematic? Or not at all? Why do they have that opinion? What's their reasoning? Does anyone want to stand up for the cactus that gets eaten by the bug?

Scarlet

Another bug that gave its blood to fashion for centuries, or rather, humans took its blood for fashion. This insect is as long as but thinner than a Kindergartner's fingernail and almost as hard. It's the Kermes, a chemical cousin of the cochineal, who lived across the oceans in Indo-Europe. From its Sanskrit name we get the words carmine and crimson. Today's Persian speakers still use the word kermes for red.

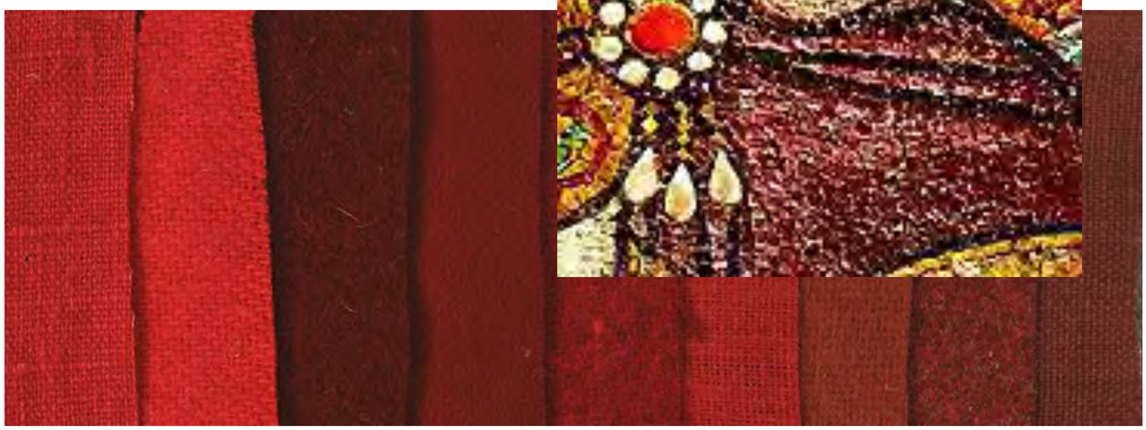


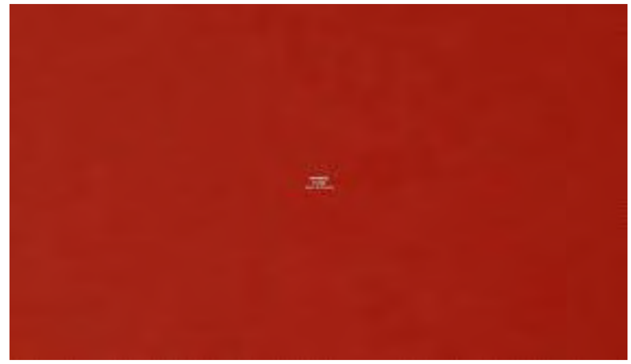
Whatever it was called, this little insect was big business. Since the Ancient Egyptians started importing it by the camel-load from Persia and Mesopotamia, the kermes trade routes had spread to cover the known world, from Europe to China. The Romans liked it so much they would demand that taxes had to be paid in sacks of kermes insects. When ruled by Rome half of Spain's taxes to the capital were in the form of kermes, which they called "grana," the other half was more conventional grains like wheat.

With such huge demand the industry was always well paid and kermes collecting was a business that was handed down for generations. Instead of being dried, like cochineal, kermes insects suffered murder by slow subjection to vinegar fumes or death by drowning in a vinegar bath. This didn't always work.

A fashion statement in medieval Europe was to wear clothes made of a new cloth, which was imported from central Asia. The cloth was called "scarlet" and it was hugely popular, frequently imitated, but the very best of it was extremely expensive—at least four times the cost of ordinary cloth. Now, the interesting thing is that this cloth was not always red, sometimes it was blue, or green, or even black. The reason that the term scarlet in English means red and not, "fashionable-cloth-that-only-the-very-richest-can-afford-but-that-we-all-really-want" is because of kermes.

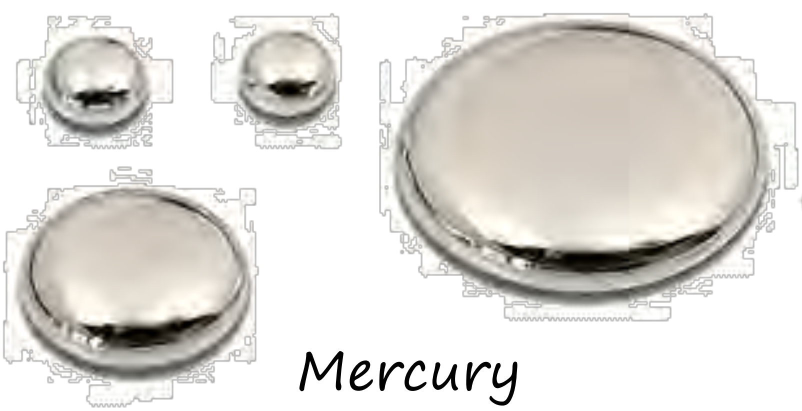
Kermes was one of the most expensive dyes in Europe, but the dyers loved it! And so what else would they use for their most valuable fabric? There were other ways of getting reds. There was madder, a root of a plant, which was relatively cheap, but it tended toward brown, not that rich crimson that people wanted. Greens and blues were popular but ultimately the most valuable cloth deserved the most valuable dye (and they could charge more!)





Vermillion

Cinnabar



Mercury

Sulfur

Orange

Human warning signs employ the same colors that nature uses to advertise dangerous creatures. Orange is a warning color—dangerous parts of machinery are deliberately painted with it, the theory being that it is the most eye catching color and people will see it and jump out of the way, it expresses a wish merely to be left alone.

Safflower is unusual. An orange flower rather like a marigold, if you add alkalis to the dye broth it is yellow; with acid it goes a beautiful crimson pink which is the color of the original "red" tape once tied around legal documents in England and now gives its name to any bureaucratic knotty and complicated process.

It would have been known to traders in the busy North African bazaars for more generations than anyone could count: Ancient Egyptians used it to dye mummy wrappings and to turn their ceremonial ointments an oily orange. They valued it so much that they put garlands of safflowers entwined with willow leaves in their relatives' tombs, to comfort them after death.

It is also a plant to be wary of. Throughout its five thousand years of cultivation safflower pickers have been easy to spot as they go to work in the fields—they have been the ones with leather chaps from the tops of their thighs to the bottom of their boots to protect them from its spines. Today, if safflower stems get in the throat of a combine it is almost impossible to get them out. “Burn the combine” is the only mostly joking solution offered by the farmers.

For buyers of colors, safflower is a dye to be careful of too, especially if you’re not actually looking for it. This plant has been switched so often for a more expensive dye materials that it has received some rather impolite names. No one is sure where it originated, whether it was India or North Africa. It is celebrated in both places, and in India and Nepal it is a holy color, perhaps because it is close to the color of gold.

Madder

Most artists would be bewildered to find madder under orange, as it tends to signify a bright pink for painters, but if dyers put white wool in a madder dye bath with a bit of alum to make the color stick it comes out a vibrant shade, a brilliant orange as bright as autumn. Madder in its root form, each piece the thickness of a pencil, although much much longer, as it grows so long and so quickly that in 17th century Holland, for example—when the Dutch were the European leaders in madder production—farmers working on reclaimed land were legally obliged to harvest their crop after two years, in case the roots grew too deeply, broke through the dykes, and caused floods. Drying it in the sun gives it a richness and then madder makers pound it with a pestle and mortar (bowl and pounder/grinder). The first pounding separates the cheap madder, the second separates the average madder, and the third pounding powders the heart of the madder root, the finest grade, which the Dutch would call “krap” and the English would adapt to “crop.” Even today, with mechanization to help, the process is still enormously time consuming and at no point in the entire process can any metal touch the mixture as it reacts and changes the final color.

How to make the brilliant orange-red or "Turkey Red" was one of the best kept secrets of the dyeing world and it would take European dyers several centuries of bribery, negotiation, and spying to uncover it and when they did, they found out it wasn't very nice for the dye-makers neighbors. It involved applying alum, tin, calcium, tannin, ox blood, and—best of all—sheep or cow dung to fiber that had previously spent some time steeping in rancid castor oil. After three weeks of going through one of the most complicated dyeing processes ever invented, the cloth and the dye works gave off a very strange stench indeed.

The boom couldn't last, and with the invention of chemical colors the world's madder crops were doomed until a small but significant revival within the last 50 years. A German chemist did his own research and rediscovered the lost art of madder dyeing. His group has inspired others. Dr. Boehmer explained the appeal of the old dyes this way, "Synthetic dyes contain just one color. But in madder there is red, of course, but blue and yellow are in there as well. It makes it softer, and at the same time more interesting." If you look at a piece of madder that has been magnified over 240x it is orange and blue and red, all swirled together.

Safflower

Madder

Yellow

"What is purple in the earth, red in the market, and yellow on the table?" Iranian Riddle

No color has a neat unambiguous symbolism, but yellow gives some of the most mixed messages of all. It is the color of pulsating life—of corn and gold and angelic haloes—and it is also at the same time a color of bile (a bitter yellow liquid used by the body to help digestion), and in animal life, yellow—especially when mixed with black—is a warning. Don't come near, it warns, or you will be stung, poisoned, bit, or otherwise generally inconvenienced. What animals or insects can students think of that are yellow, or yellow and black? (bees, tigers, hornets) In Asia yellow is the color of power—the emperors of China were the only ones allowed to wear sunshine-colored robes. But it is also the color of declining power. A sallow complexion comes with sickness; yellowing leaves in autumn not only symbolize their death, but indicate it. It shows they are not absorbing the same light energy the they used to take in when they were green and full of chlorophyll and no longer have what it takes to nourish them.

Indian Yellow

For years in both England and parts of India the ingredients of Indian yellow were a mystery. Throughout the 19th century little packages came to colormen in London from Calcutta sealed no doubt with plenty of string and sealing wax. Those who sniffed the stale and odd smelling contents must have wondered where they came from and what they were made of. Some suggested it was snake urine, others thought it might be something that had been dug out of the insides of animals (like the bile from ox livers that was used to make yellow in the 18th century), some said the powdery, light, spongy, soft lumps were made from camel urine, and a German scientist declared in 1855 that he knew it was excrement from camels that had eaten mango fruits. The color faded quickly and its unknown origins make it mysterious.

Why are pencils yellow?

When the world's richest seam of blacklead, or graphite, was found right by the Chinese border in 1847 suddenly everyone wanted "Chinese" pencils as that graphite was deemed the best. In a brilliant marketing move a few decades later mass produced pencils were painted bright yellow, copying the color of Manchu imperial robes and symbolizing the mystery and romance of the Orient. Also suggesting that they came from that special and valuable mine, even though they probably did not. Most pencils are still painted yellow, even though that graphite hasn't been used for years!

Then one day in 1883 a letter arrived at the Society of Arts in London, from a Mr. T.N. Mukharji of Calcutta. The gentleman had been asked to investigate the mysterious origins of Indian Yellow by the director of the Kew Gardens and said he could now confirm exactly what Indian Yellow was made from. He said he had recently visited the only place in India where it came from and the information he gave may have been shocking to some readers of the time, but he told them that Indian Yellow was made from the urine of cows fed with mango leaves. He assured his readers that he had actually seen them eating mango leaves and urinating—on demand—into buckets. He also warned they looked rather unhealthy and were said to die early. Due to his report, the process was considered inhumane and, since 1908, Indian Yellow pigment has been prohibited from the market.

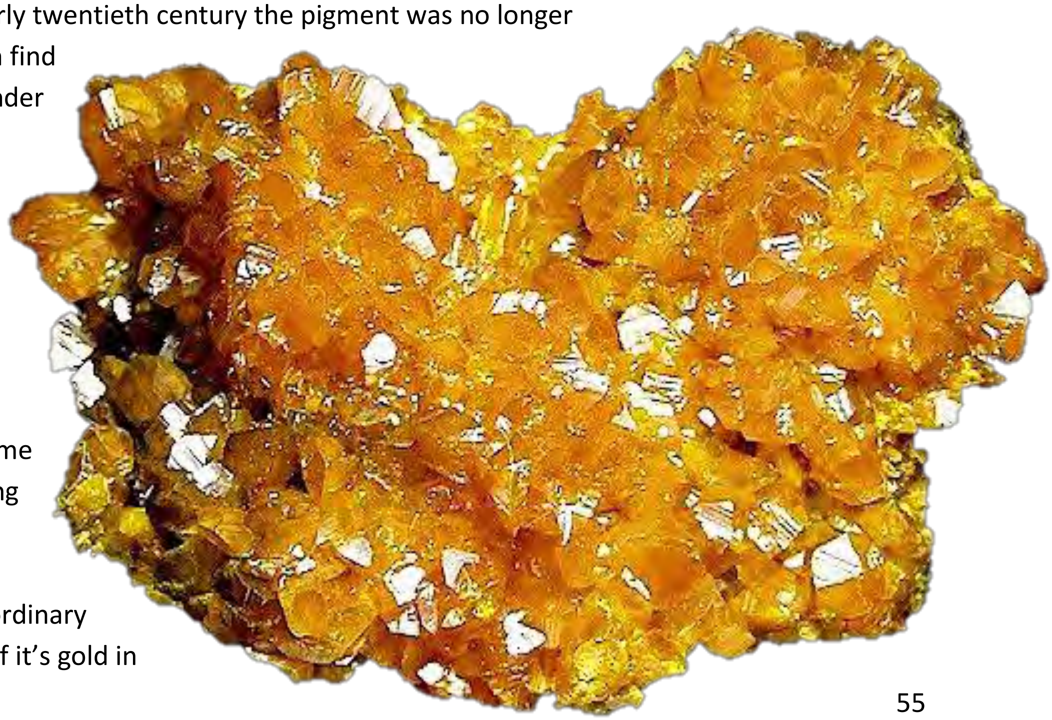
But no one since has been to corroborate his story. Though it is believed it was a paint that was made of some kind of urine and some kind of mangoes. *The cow urine was evaporated and the resultant dry matter formed into balls by hand.*

The urine was "heated in order to precipitate the yellow matter, then strained, pressed into lumps by hand and dried." By the early twentieth century the pigment was no longer available, although you can find modern substitutes sold under the name "Indian yellow".

So, even to this day the secret of Indian Yellow remains a secret.

Orpiment

Orpiment means “gold pigment.” And for a long time it was an immensely exciting commodity for alchemists (early experimenters) who were seeing to transform ordinary metals into gold. After all, if it’s gold in



color, went the argument, then it must surely share characteristics with gold, and could be used for transformations. Adding to their firm belief was the fact that orpiment transforms miraculously from something brown to something beautiful.

Artists were less thrilled than the alchemists, not only because anything it is put over blackens, but also because it contains the deadly poison arsenic, though some were willing to risk it. You definitely wouldn't want to lick your brush! The Chinese had a less cautious attitude about it than their European counterparts (they didn't see it as poison) and would use it for painting paper, and to color a special gold, red, and white linen, called krinsing. After spreading orpiment on the cloth they would hang it up for days in a smoky room to make the color fix. They also, according to some historians, took it fearlessly as medicine, in small quantities, as it was believed to to improve their complexions, strength, etc. One historian, in 1660, reported he had seen a woman who had become mad from it and was climbing up walls like a cat.

Gamboge

Gamboge yellow has been used across Southeast Asia in art going back to at least the 8th century. It was used in India as a less smelly alternative to cow urine yellow and it is always imported. Gamboge comes mainly from Cambodia, the word gamboge is actually a corruption of the name Cambodia, though it does appear in a few other countries, ex. Thailand. In the 1880s King Chulalongkorn sent some good samples of the resin to the US as part of a "gift of respect."

Gamboge comes from a tall tree related to the mangosteen, but it doesn't make delicious fruit. The paint comes from the resin of the tree and is extracted in a similar method to rubber extraction—except for one critical difference. A semicircular slash in a rubber tree trunk bleeds latex within a few hours which can be collected the next morning. By contrast, gamboge collectors makes their cut deep into the trunk, carefully placing a hollowed-out bamboo beneath the gash…and don't come back until the next year! It takes years to collect a big enough blob to sell to paint suppliers. And in the course of those years, the sap collects souvenirs of the things happening around it.

During times of war the color is nearly impossible to find. It gets mixed with mud when the gamboge holders fall onto the ground, and even then people hunt for the “dirty gamboge” which dripped onto the soil and is full of impurities because that is all that can be found. Sometimes more than dirt is mixed in. Windsor & Newton have been receiving small packages of gamboge from their Southeast Asian suppliers since the company began in the 1800s. But in some of the packages that arrived in the 1970s and 1980s from Cambodia and possibly Vietnam were different: the gamboge contained exploded bullets. Five of them are displayed in the offices at Windsor Newton to remind them that some of the paint materials we so easily take for granted come from places where people have lived through unimaginable suffering. One day, a group of soldiers went into the garcinia grove and sprayed bullets with a machine gun. Some of them lodged safely in the bamboo, to be found months or years later by paint-makers in Harrow. What happened to the other bullets can only be imagined. Even today where gamboge is harvested land mines left over from wars still kill and people die for gamboge.

Gummi Gutti
Gamboge

Exploded bullets found in Gamboge

It’s also poisonous itself, it won’t kill you like orpiment, but it is one of the most efficient diuretics that nature knows, put it accidentally in your mouth and you’ll be in the bathroom all day! Another yellow dye, buckthorn, has the same effect. In fact it is quite a characteristic of things are yellow. Gourds, unripe pineapple, yellow dock root, and yellow flag irises all have the same violently purgative intestinal effect.

Tie-Dye by other Names

For centuries, cultures in many parts of the world have developed methods of masking portions of cloth or yarn so that these areas can be exposed to dye at different times in order to achieve greater control over the results. Often referred to as "resist dyeing" common techniques for preventing dye from reaching selected areas are applying wax or tightly binding off or knotting the fiber or yarn in some way, just like in tie dye! Though it's called *shibori, plangi, bandhani,* and *batik* in other parts of the world.

Immersion dyeing is used primarily to apply a more or less solid color to fiber. But there are ways to make this process even more fun and the results more exciting. Once you've mastered the immersion technique, you can experiment with fiber to achieve many different effects.

For instance, altering the state of the fiber before introducing it to the dye-bath can create very interesting outcomes. Not only premordanting but binding, clamping, folding, and knotting are just some of the techniques they can use.

The following creative approaches tie dyeing are meant to excite student curiosity and get them to start thinking, "What if?" For instance, "What if I tie resists on the fiber and dip only one end into a blue dyestock and then dip the other into a red dyestock?" "What if after I heat-set the fiber, I remove the resists and dip into diluted color?" It's a good opportunity for students to use their imagination. The very worst thing that can happen is that students overdye the fiber.

Presoaking the yarn before applying the resist ties serves a purpose. It expands fiber, and when the ties are snug, they do a better job of preventing the dye from penetrating the bound-off areas, dry fiber wicks dye into the bound off areas.

As they plan their tie-dye fiber project, remind students to keep in mind that whatever they use for their second dyebath will not only color the undyed (white) areas from the first dyebath, but it will also overdye the fiber that received color in the first dyebath. For example if the initial dyebath is red and you use blue for the second dyebath will be dyed blue but the area that received dye will now become purple.

Instead of using two different colors, you may wish to simply make the second dyebath a paler shade than the first one. As with so many dye processes the possibilities are endless!

Materials:

- Work surface prepared for dyeing
- Approximately ¼ pound of fiber per student
- Scrap yarns for ties
- Citric acid solution or vinegar-water solution of 1 part white vinegar to 3 parts water

- Dyestock, ex: using something like PRO WashFast Acid Dyes (ex. Dark Pink (base), Lemon Drop (2^{nd} color), Chile Pepper (sprinkle)
- Vinyl Gloves
- Large microwave-safe bowl with lid
- Syringes: Syringes are great for precise placement of dye, for measuring small dye amounts, and for injecting dye inside a bundle of fiber
- Microwave

Method:

1. **Prepare the fiber**. Tie the skein of yarn with figure eights as described earlier and soak it in the vinegar-and-water solution for about 30 minutes. Remove it from the solution and allow it to drip dry until damp.

2. **Mix the dyestock.** Prepare two different colored dye solutions. (a "sprinkle" is unmixed dye powder)

3. **Prepare the dyebath.** Fill a bowl about 2/3 full of water, and add 1 cup of white vinegar. Or mix in at a rate of 1 to 1.5 tablespoons of citric acid into each 1 quart (4 cups) of water.

4. **Tie resists around the skein**. Wrap a length of scrap yarn or shoelace around the damp skein and secure it tightly. Tie additional pieces of scrap yarn at several intervals around the skein in the same way. These ties, known as "resists," prevent the dye from entering the bound-off areas.

5. **Heat set.** Place the prepared fiber in the dyebath, cover the bowl, and place it in the microwave. Set the heat on HIGH for 1 minute then check to see if the dye is being absorbed. Continue to heat and check until the water runs clear.

6. **Untie the fiber.** Pour off the water. With gloved hands spread the skein out on a prepared work surface and remove the ties.

7. **Drip-paint.** Drip or pour the second color over the areas that received no color in the dye bath because they were tied off. You'll see that this dye blends and transitions nicely into the dyed areas, taking on a 3^{rd} color. Place the skein back in the bowl.

8. **Sprinkle dye powder (optional).** For an extra touch of color, sprinkle dye powder directly on the yarn before the final heat set, if desired.

Mixing Dyestock

Before you begin any project you'll need to mix up dyestock. Wear a mask to avoid inhaling the dye powder and vinyl gloves to protect your hands from stain. Place 1 tsp of acid dye powder in a cup or jar, add a little tepid water and mix to dissolve the powder. Add enough boiling water to bring the mixture to 1 cup, and combine thoroughly.

The dyestock should be at room temperature before you apply it directly to fiber. If pressed for time, pour ½ cup of boiling water into the dissolved paste, mix thoroughly, and then add ½ cup of tepid water. This speeds up the cooling process and you're ready to dye.

9. **Heat Set.** Repeat step 5 above. Allow to cool to room temperature.

10. **Finish up.** Remove the yarn and rinse with tepid water. Squeeze out or spin to remove excess water, and hang to dry.

Variation: Tie-Dye/Drip-Dye Combo

This project combines two techniques and it results in multi-layered, potentially sophisticated color scheme. You first prepare the fiber for tie-dyeing and dye it using the immersion method. You then untie the resists, drip new dye colors over the skein, and then heat-set it in a microwave. Some of the drip-dye will overdye the areas dyed by immersion, and some will saturate the undyed, white areas, with the results of having at least three different shades. Have fun!

1. Prepare the fiber. Tie the skein of yarn with figure eights and soak it in vinegar-water or citric-acid water for about 30 minutes. Remove it from the soak and squeeze it to remove excess water.

2. Tie the fiber. Wrap a length of scrap yarn around the damp skein and secure it tightly. Tie additional pieces of

scrap yarn at several intervals around the skein in the same way.

3. Heat the water. Fill a pot half full with water, and add 1 cup of white vinegar, or the appropriate amount of citric acid. Place the pot on the stovetop and bring the water up to simmer. Stir the desired amount of dyestock into the simmering water until it's well mixed. Remember, you can always add more color if necessary, but you can't take it out, so begin with a smaller amount than you think you need.

4. Immerse the entire skein. Gently poke the fiber into the dyebath. When the water is barely at a simmer, set the timer for about 30 minutes, and keep the water just below simmering. Move the fiber enough to allow all of the dye to come in contact with the fiber but don't' agitate it so much that it begins to felt. Continue to occasionally poke the fiber to gently move it around in the pot.

5. Test for dye absorption. Check to see if the dye has been absorbed by the fiber by carefully scooping up some of the dyebath in a clear glass container. Once the water is clear, turn off the burner and let the bath cool to room temperature.

6. Untie the fiber. Remove the skein from the dyebath, and with gloved hands, spread it out on a prepared work surface and romve the ties.

7. Drip-Dye

Green

Green, in many ways the most "natural" color in the world, after all, most of the world (even some of the bits covered by the sea) is green. Yet for artists and dyers it has long been a difficult color to reproduce, and this most "organic" of colors—the color of grass and trees and fields—has in fact often been the hardest to create and is most often made from metal, or, to be more accurate the corrosion of metal.

Green has been associated with Mother Nature, Indian mysticism, Persian poems, and Buddhist paintings and it became incredibly popular in the 1790s when poets like William Wordsworth writing of dancing leaves and "Thou, Linnet! in thy green array," reflecting the suddenly widespread feeling that nature was something rather wondrous instead of something dangerous, and that, in all ways, Green was Good! But in terms of color, especially in paint, this sentiment was to prove fatally wrong.

The most fashionable houses were covered in green, with hand painted wallpapers—green tendrils creeping up the walls with extra birds, flowers, and even banana trees pasted on top. Wallpapers from China had first been used on English walls in 1650 and were still popular over 180 years later.

Even Napoleon's(Napoleon Bonaparte, the first emperor of France, who started wars and wanted to take over Europe and beyond,) own house, and bedroom, located on the prison island of St. Helena in the remote Atlantic where he was sent after having been captured by his enemies, not allowed to see his family again, he named it "questa piedra maladetta — this cursed rock." At the time it was a damp and cheerless place crawling with mold and festooned with cobwebs that his servants camouflaged by hanging fabric and paper on the walls and ceilings, green wallpaper. A wallpaper that certainly helped drive him to his deathbed in 1821 at age 51, but it wouldn't be figured out for 140 years, and it would only be discovered because someone bought his hair.

In 1960 someone bought a relic, or piece of Napoleon’s body, in this case, his hair and they had it tested at a lab to make sure it was genuine perhaps, and see if they could find out anything new about him, even 140 years later. What they found out shocked them. They found arsenic, lots of arsenic. Which led to a huge number of questions. Did the fallen emperor really die of stomach cancer like his doctors declared, from sadness as some historians claimed, or had something more sinister, perhaps a poisoning, taken place? Historians read Napoleon’s diaries for clues, but he only complained about the weather (damp, wet, and more damp!) and the new governor who he despised, but no clues to his poisoner. But, there was another possible answer to the arsenic question and it was connected to green.

A Swedish chemist was working in 1775 with copper and arsenic and, almost accidentally, invented a new and rather astonishing green. Very soon he was manufacturing his new color (he had invented a yellow a few years earlier, but a British manufacturer stole it and patented it before he could) under the name Scheele’s Green, but there was something that had him worried. He confided in a friend in a letter that he was a bit worried about the poisonous nature of the paint, that perhaps the people should be warned about the danger when they bought it, but really, what’s a little arsenic when you’ve got a great new paint to sell, right? Soon manufacturers were mixing it into many paints, papers, and more and people happily pasted poison onto their walls for years.

Perhaps, historians began to think, this might explain the mystery of Napoleon and his poisoner. Then in 1980 a British chemistry professor signed off his science program with a little teaser. If only we could see the color of Napoleon’s wallpaper, he said, we might know whether it was the true cause of his death! To Dr. Jone’s shock he received a letter from a woman who by astonishing coincidence actually had a piece of Napoleon’s wallpaper! An ancestor who had visited the house had secretly torn a strip of the wallpaper off the wall of the room where Napoleon had died, and stuck it in a scrapbook. Dr. Jones tested it and to his excitement he found traces of Scheele’s green arsenite in its pattern. When he learned how wet St. Helena was he became more excited: the mold reacting to the arsenic would have made the whole atmosphere poisonous. The Scheele’s Green theory explained the arsenic, and the possibility of fumes in the air gave a clue as to why the formerly active soldier spent so many of his last months lying on one of his two camp beds (he never could decide which was better). But perhaps there wasn’t enough green there to truly explain the final cause, his doctors had declared it stomach cancer.

It took the medical world a long time to react to cases of wallpaper poisoning. As late as January 1880, more than 100 years after Scheele invented his poisonous green, a researcher stood in front of the Society of Arts in London and held up a sample of cute nursery wallpaper (pictures of boys playing cricket on a village green) which had recently killed one of his young relatives and made the child's siblings seriously ill. He gave other horrifying examples of arsenic poisoning—an invalid who went to the sea for her health and almost died because of the paint in her hotel, a team of decorators who developed convulsions, even a Persian cat that became covered in sores after being locked in a green room. And it wasn't only green, some blues, some yellows, and the new magenta also held arsenic. He had found it on paint, wallpaper, carpet, clothing fabrics, everywhere. And when two or three grains will kill a healthy man, an output of 4,809 tons in one year, is a large quantity, and a large problem.

Not everyone agreed though that it was really a risk. As one said, when he looked at the lovely greens and other colors possible with arsenical paper, as opposed to the dull colors made without arsenic, he could not help thinking that he wanted arsenical paper on his walls.

The love of green is one shared by many, for after all, it is the most "natural" color in the world. Other greens have not been so dangerous, and one even served as the first "sunglasses" for a civilization so cool its people would have loved to wear shades.

Malachite

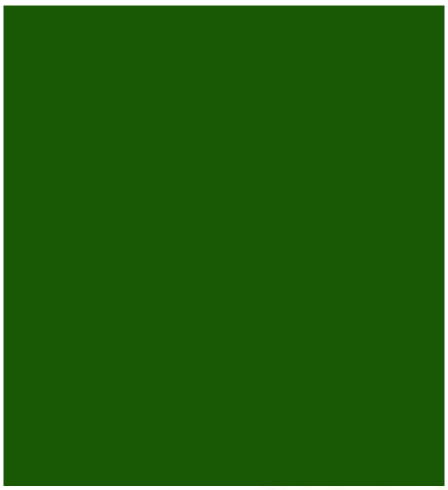
Malachite was probably first used as a pigment by the Ancient Egyptians who ground it up and used it on their paintings, and their eyelids, as it made a very pretty pale green eye shadow (as long as it wasn't ground too much) and was used, along with kohl, to protect their lids against the glare of the sun (see, sunglasses!) If you grind it too much malachite has a dingy or ashy color. Since the Ancient Greeks it was believed to be a protective stone that would help keep a person safe from evil.

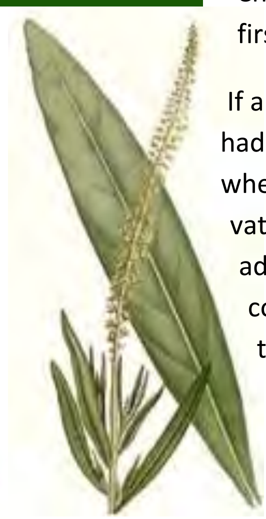
Eighth-century Chinese artists used to grind malachite—coarsely—for the haloes of their Buddhas, and from Japan to Tibet it was a hugely popular pigment for hundreds of years. According to the ancient Chinese the best color comes from stone the "color of a frog's back," but what's interesting is that in its uncut form, malachite has a texture something like the texture of a frog, or toads, back anyway. It is covered in warty bumps, that when sliced into a cross section, create the pretty circle patterns for which it is famous.

Malachite green is still used today to get rid of mold on goldfish, though it has the rather unfortunate side effect of making them greenfish for a while.

A One-Pot Dye

Greens had travelled from China to Europe, and knowledge of other greens went from Persia to Europe, but probably one of the last times green color moved lucratively in that East to West direction was in 1845. That year an official team from France went to China to investigate the potential for new trading items. China had just lost Hong Kong Island to the British a couple years before and the French wanted to see if they could get anything for themselves, aka land. They came back with objects, but no new land. But among the textiles, porcelains, and mineral samples was something a little less obviously valuable, just a few pots of green mud. But for a while it seemed that they were going to be the greatest treasure of all: these seemingly simple little pots of mud promised to revolutionize European dyeing in the same way that cochineal had revolutionized it over three hundred years before. The mud was called Lo Kao, or Chinese Green, and it caused huge excitement because it was the first ever one-pot natural green dye.





Weld

If artists had problems with green, dyers had it a lot worse. Green had never been an easy color for fiber artists to create, and it tended, when they could do it, to require them dipping the cloth into two vats—a blue one and a yellow one. Together with the problem of adding mordants, getting the right temperatures, the right concentrations, all this dipping meant you weren't very likely to get the same color twice in a row. And there were issues with fading! So if dyers could get some kind of consistency that fabric or fiber was very highly prized.

The legends of Robin Hood and his merry men, for example, describe them as wearing "Lincoln Green." Now, we might imagine that was for camouflage, after all, they lived in the woods, but the truth was they were wearing it to show off! The green cloth was the pride of Lincoln, made of woad (a blue dye) and weld (a yellow one). It was also called "gaudy green," and it was very expensive. Wearing it was a way for the legendary bandit to laugh at his rivals and show how he was stealing from the rich to clothe the poor (literally, in some very expensive cloth!)

So for dyers, the apparently fade-resistant Lo Kao was a double boon, and the French traders were positive it was going to make them very very rich. With the Chinese gunk it was ridiculously easy to make a good green. The recipe would be rather like this: Put mud in pot. Boil. Add cloth or fiber to pot. Clean and dry. The end.

What was not simple was the process that suppliers in China had to go through to make the green mud in the first place! It was made from two Chinese varieties of buckthorn trees: *Rhamnus utilus* (useful) and *Rhamnus chlorophorus* (green). Common buckthorn, or Rhamnus cathartica ("cathartica" because of what it does to your bowels if you dare eat the yellow berries) had been stripped of its leaves for thousands of years to make dyes and paints, and since the 17^{th} centuries had also been boiled with alum to make a not very popular watercolor paint called bladder green, which referred to the pigs bladders the artists stored it in to keep it moist, not its yellowy green color.

Lo Kao wasn't made from leaves or berries, but rather, the bark, which the Europeans never seemed to have thought of. Perhaps this isn't a surprise as the process is incredibly complex and perhaps the biggest surprise is that anyone did. The bark had to be boiled for several days and then a length of cloth would be thrown in. Several days alter the cloth—now brown—would be removed from the broth in the evening, and left to dry through the sunshine the next morning. Precisely at the stroke of midday the cloth was brought inside and wherever the sun touched it, it would be green. The cloth was then boiled again until the green pigment soaked off into the pot. The sediment at the bottom was collected, dried, exported, and sold for incredibly high prices.

Unfortunately for the Frenchmen, man-made dyes were waiting in the wings and Chinese green was so expensive it was one of the first dyes to be completely replaced by synthetics. The new synthetic greens headed straight from the European laboratories towards Asia. Green color technology had headed from east to west for so long, celebrating nature. And now it was heading the other way---celebrating technology.

Robin of the Hood and His Merry Green-Clad Men

Have students brainstorm as many things as they can that are related to Robin Hood. Tell them to think about any stories they've read or films they've seen. Give them a couple of minutes, then write their ideas on the board.

You could almost assume every American child has heard of Robin Hood. Robin and his merry outlaw band have been the heroes of books, motion pictures, plays, games, songs, and even operas for hundreds of years. The many film versions of his story attest to his enduring popularity. Who was this hero, and what makes him so popular? Literary references of Robin Hood -- beloved today as a vigilante outlaw (seeking justice) and rebellious philanthropist (giving money away to the poor)-- stretch back to at least the 1300s. Retold in countless variations, Robin Hood's resume has been expanded and enriched extensively during the intervening centuries. Poets, playwrights and directors have all seized on the good outlaw theme and run with it, breathing new life into the legend again and again. This in turn has led many researchers to sort through the annals of the past, attempting to uncover the man behind the myth, the real Robin Hood who inspired such a devoted following.

But history is as murky as a forest blanketed in fog. Discerning the truth through hundreds of years of history and speculation is like trying to hit a target with an arrow while blindfolded. Plus any applicable and relevant facts and public records, ones that could determine the truth once and for all, likely either no longer exist or possibly never existed in the first place. But which is the case?

Certainly some of the historical characters who appear in the Robin Hood stories were real. Richard the Lion Hearted, Robin's king, ruled England from 1189-1199 and did lead the third Crusade. His brother John, the villain of many of the Robin Hood stories, signed the Magna Carta in 1215, but the existence of Robin Hood himself cannot be proved.

During the Middle Ages, common people told stories by singing ballads. These songs, which often had four-line stanzas and a set rhyme scheme, were passed down orally, and often changed to reflect the changing lives of the storytellers who sang and composed them and the audiences who listened to them. Although many of these ballads told tragic love stories, often including elements of the supernatural, some were simply tales of heroes and their adventures.

Over 40 of these collected songs mention Robin Hood; the earliest one, “Robin Hood and the Monk,” is dated 1450. Another, “The Geste of Robin Hood,” seems more epic poem than ballad, for it contains 456 stanzas. In fact, Robin Hood appears in more ballads than any other figure.

What qualities make a hero? Before they begin reading any texts, have students generate a list of traits they believe to be heroic. As you read stories and poems, have students keep track of which of these traits characters in the Robin Hood tales display.

Although Robin Hood ballads tell many different stories of the outlaw, and even place him at different times in history, all of them do share a theme, the “righting of wrong and the downfall of those who abused the office and authority.” However pleasantly wicked Robin Hood can sometimes be, and a part of his attraction surely rests in every child’s dream of the rebellious bad boy who defies authority yet escapes punishment, Robin Hood and his band have very strict rules concerning moral behavior, rules very similar to the knightly code.

Is there ever a time when it is necessary, even right, to break a law? Ask students to write a brief response to this question and then discuss their answers. Explore the possibility that someone who breaks a law might actually be a hero. Under what circumstances might breaking the law establish someone as a hero?

Do you feel any sympathy for Robin’s archenemy, the Sheriff? Can you imagine his point of view about Robin and his band?

Knights of his time swore to defend the weak and helpless, to protect women and children, to fight only in just causes, to grant mercy to their enemies, to deal honorably with opponents in battle, and to defend Christianity and Christians. Robin Hood’s outlaw band swears essentially the same oaths. They steal, but only from the rich and not out of greed; their wealth is freely given to the poor. They willingly help anyone who needs their aid, whether or not that person can pay for the aid. No woman or poor man is ever assaulted in Sherwood Forest; only rich lords or bishops need fear the bandits. Even in battle Robin Hood is strictly fair, refusing to take advantage of an opponent’s weakness and always honoring his word to any man, even an enemy. At the end of his life, dying in his best friend’s arms, Robin refuses to grant Little John’s request to take vengeance on the person responsible for his death. For one thing, she is a woman and for another, to seek revenge would have been unchristian.

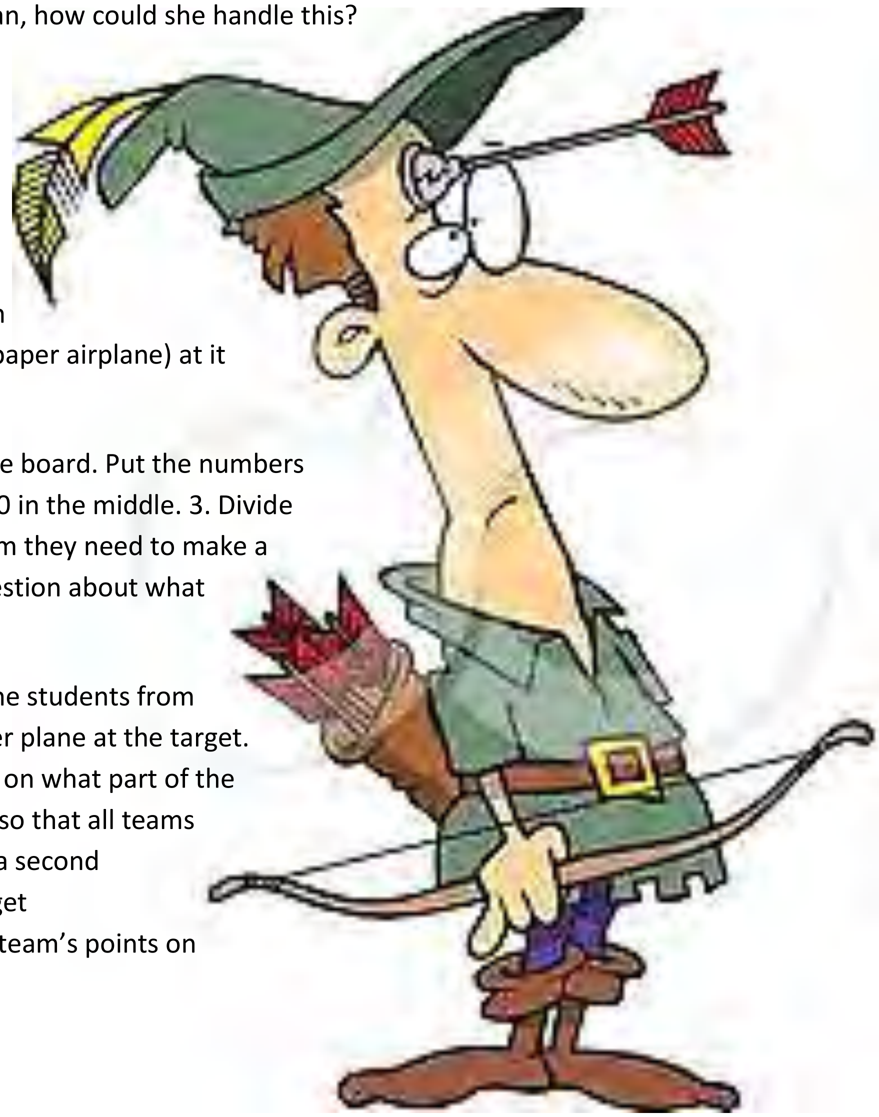
Generations of children and adults have been drawn to Robin because he is that wonderful oxymoron, an honorable outlaw. Adventurous, brave, manly, fair, funny, chivalrous, charitable, romantic, loyal, skillful, cunning, yet wonderfully able to laugh at himself. This fine warrior – the very best with a bow – loves to play tricks and get away with them, but his integrity is above question. And unlike many legendary heroes who rule by right of birth or by prowess alone, Robin’s men recognize his worth and vote him into power; the society of Sherwood Forest is essentially a democracy. King Richard marvels when he witnesses the loyalty of Robin’s men for their leader. This loyalty is well earned.

Scholars and amateur enthusiasts have pored over scraps of such records and remnants of text trying to piece together the puzzle of one of history's most renowned characters. However, whether he was a character in the sense of an actual personage, or simply a character in the fictional sense, remains inconclusive.

Now, take everything you know about Robin Hood and his Merry Men and turn it on its ear. What if Robin weren't a young man, but a young woman disguised as a man for protection? What if Maid Marian was her little sister? Would that change your perspective on her? Why or why not? How would it change the stories?

Have students write their ideas down. Think of questions to discuss, ex. Will Robin ever reveal her secret, her true identity? Will she ever see her family again? If she starts developing feelings for one of her Merry Men who still thinks she's a man, how could she handle this?

Hit the Target



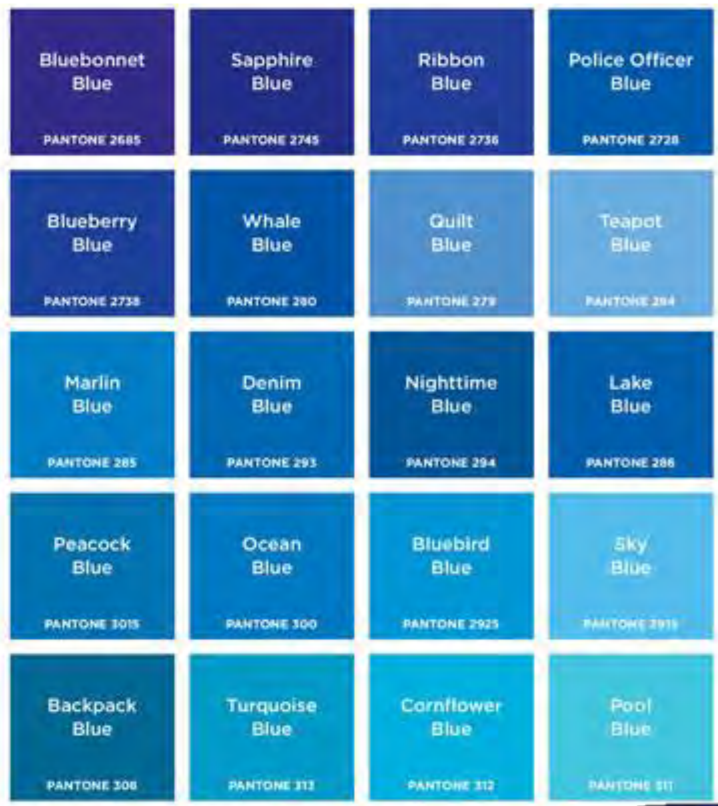
A game that always works well as a review is where the teacher draws a large target on the board (like one used in archery) and students have to throw an object (usually a beanbag, paperwad, or paper airplane) at it from an agreed distance to score points.

Draw a large target with three rings on the board. Put the numbers 10, 20, 30 in each ring with the number 30 in the middle. 3. Divide the students into teams and tell each team they need to make a paper airplane. Then ask each team a question about what they've studied so far in turn.

When a team answers correctly, one of the students from that team has the right to throw the paper plane at the target. They score 10, 20 or 30 points depending on what part of the target they hit. Put a marker on the floor so that all teams throw from the same distance and allow a second chance if the first attempt misses the target completely! Keep a running total of each team's points on the board.

Blue

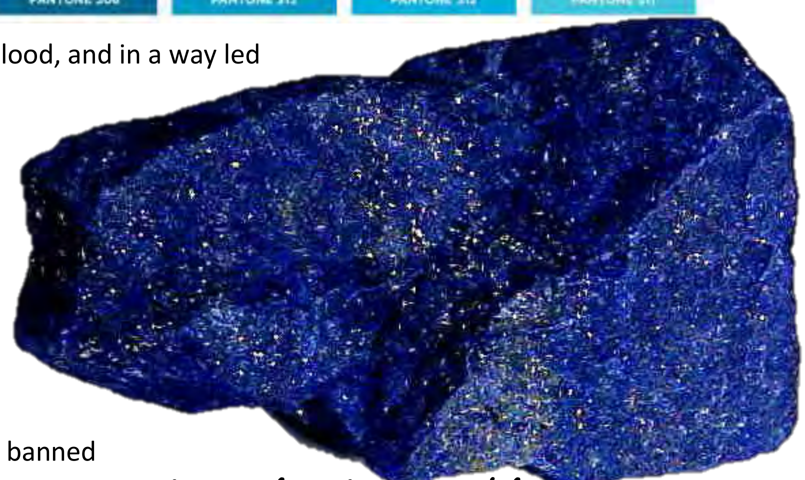
A story is told that all the true ultramarine paint in the world comes from one mine in the heart of Asia. And that before it could be squeezed sparingly onto any European artist's palette (mixed with linseed oil or egg like an exotic blue mayonnaise) it had journeyed in rough sacks on the backs of donkeys along the world's ancient trade roads.



Ultramarine is a word that always seems to taste of the ocean, with a smooth salty sound, suggesting a bluer blue than the Mediterranean, but medieval Italians had no intention of summoning specific sea-color images when they gave this marine name to their most treasured paint. *Oltramarino* was a technical term meaning "from beyond the seas," and was to refer to several imported items, not just paint. And this particular oltramarino certainly came from way beyond the seas: the paint is made of the semi-precious stone lapis lazuli: It is found only in Chile, Zambia, a few small mines in Sibera, and—most importantly—in Afghanistan.

It's a color that has inspired much imitation, artists used to try to capture it by experimenting with paints made of copper and blood, and in a way led to the discovery of cobalt. More on that later…

Except for a few Russian art pieces, colored with blue from Siberia, all the real ultramarine in both Western and Eastern art comes from one set of mines in a valley in north-east Afghanistan, collectively named Sare-e-sang, the Place of Stone, a village so small it isn't even marked on a map, and very hard to find, the mysterious place where blue is born, women are banned (the government feels that families will be a distraction to



Lapis Lazuli

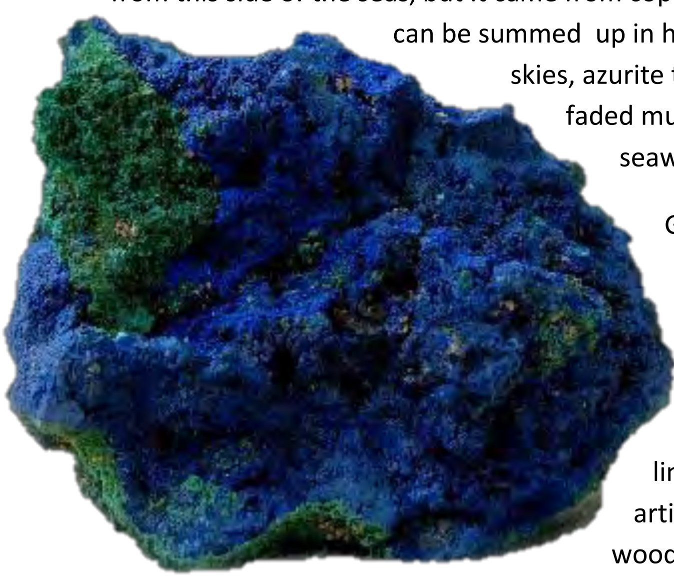
the miners), and tourists are not welcome. Part of the mystery of lapis was that although it had traveled to Europe and Egypt for thousands of years, it was always known to come from a mythical land so far away that no European or Egyptian had ever actually been there.

Today they drill holes in the rock and dynamite the stones out. In the past, miners used to light fires under the rock, and then they would throw icy water over it—carried from the rivers by young boys. Shocked by the rapid changes in temperature, the rock would crack and the miners would uncover the precious blue stones.

Ultramarine

In medieval times it was so expensive that artists could not buy their own, they would have to wait for their rich patrons to buy their paints for them. The stones were kept as part of savings, like one would save silver. One artist wrote a furious letter that 100 florins he could barely buy a pound. Today the paint, costs about $3819.75 for the exact same amount.

Artists could use a cheaper blue pigment called azurite, sometimes called “citramarino” meaning it caem from this side of the seas, but it came from copper mines and tended to be more green. The difference can be summed up in how artists used them, ultramarine to give height to the skies, azurite to give depths to the seas. The cheaper pigment also faded much faster, fading from the color of the sea to the color of seaweed.



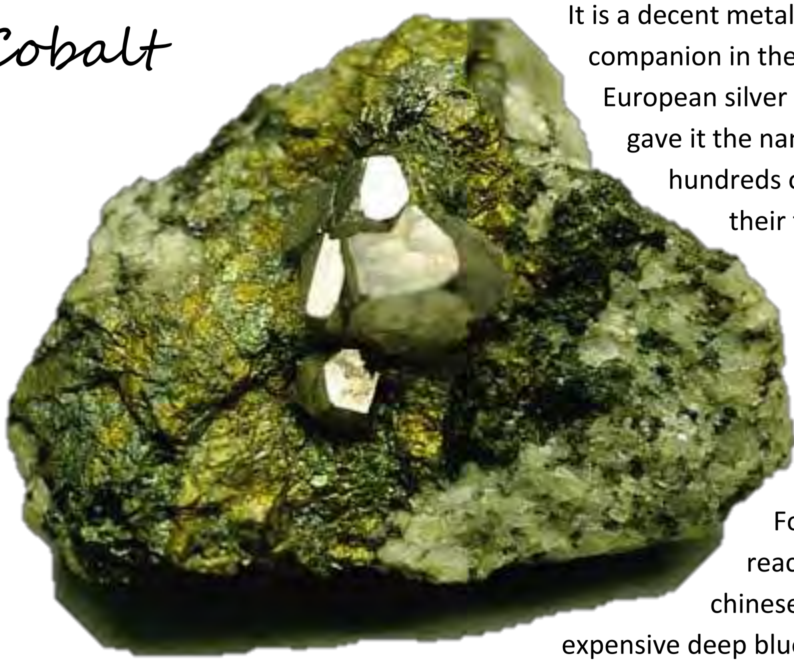
Azurite

Getting color from lapis lazuli is almost as hard as getting blood. To mae it into paint all the impurities—including the specks of fools gold that sprinkle through all lapis lazuli like stars—must be removed. To achieve that the color-makers had to be like a baker, kneading a dough of finely powdered lapis, resin, wax, gum, and linseed oil for up to three days. To coax out the blue the artist-cook put the dough into a bowl of wood ash or water, and then kneeded it further with two sticks, squeezing and pressing for hour upon hour until the water turned a deep blue. He then separated it into a clean bowl—leaving it to dry into powder—and began again with the same ball, each progressive bowl of blue dye being worth less and less money, as the first pressing was the best and most blue.

Polished Lapis Lazuli

There was another blue that travelled from Persia and through to China. It was not quite so valuable, but it was valued. It came from mines in Persia, now Iran, and in English it is was called “cobalt.” Calling it “cobalt” is rather like calling it goblin. In German folk legends Kobald was the name of a rather vicious and nasty sprite who lived deep in the earth and hated intruders.

Cobalt



It is a decent metal on its own, but it attracts a nasty companion in the form of arsenic, a deadly poison. So European silver miners who often came across it hated it, gave it the name of a German nightmare, and for hundreds of years simply threw it away before it ate their feet and attacked their lungs.

Colbalt was sued in glass since the 1500s, but it didn’t reach paintboxes in Europe until the 1800s, when a scientist finally figured out how to make it into a pigment.

For many years before it reached Europe the chinese coveted the expensive deep blue so much that for 400 years they would swap green for blue—sending green ware to Persia and getting blue back to make their famous blue and white pottery.

Another blue was created by accident by a paintmaker who was actually aiming for red. He was settling down to make carmine by the time tested recipe—mixing ground-up cochineal bugs, alum, and iron, then treating it with an acid—when he realized he had run out of his acid. He borrowed some from his boss, not realizing it had been mixed with animal oil. Suddenly, to his shock, he found blue instead of red. The key was the animal element, mixing blood with iron, he had created a color he called “Prussian blue,” which was instantly popular as housepaint. The end of it’s era of popularity is symbolized by a decision by the American crayon company to change the name of its Prussian blue crayone to midnight blue. Why? Because teachers were complaining that kids just couldn’t relate to Prussian history anymore.

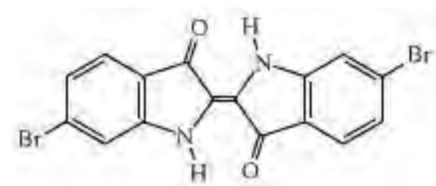
Prussian Blue

Purple

The Price of Purple

In the Mediterranean before the advent of Christianity, a whole dyeing industry arose around Tyrian purple. Tyrean purple, the most expensive and sought after dye of classical antiquity was a mucous secretion from some species of sea snails. The snail s use the discharge for hunting and to protect their eggs from microbes and disease, humans use it for color. The snail also secretes this substance when it is poked or physically attacked by humans. Therefore the dye can be collected either by "milking" the snails, which is more labor intensive but is a renewable resource, or by collecting and then crushing the snails completely, which is destructive.

The shells were crushed to extract this milky fluid, which only turns purple once it has been applied to the fiber and exposed to light and oxidation with the air. The Phoenicians, skillful shipbuilders and sailors that they were, scoured the coastlines for sight of these whelk shells, and established a dyeworks and trading station wherever they found a plentiful population of these snails. The dye, and the cloth made from it, was so famous that the Greeks called the land of Tyre and Sidon (equivalent to modern Lebanon) Phoinike, "the land of the purple".



Tyrian Purple

Since more than ten thousand murexes were needed to dye a single garment, the color remained one of the ultimate luxuries of the classical world for millennia to come. Although the Greeks were the original customers, it was the Romans who became purple fanatics. They liked a dark shade, achieved by using dyes from two species of murex, one a dark

Tyrian Purple

indigo. Pliny the Elder described it as the "color of clotted blood" (sounds lovely!) and wrote that "it brightens every garment, and shares with gold the glory of the triumph".

Tyrian purple was the color of aristocracy and the super elite. To produce the richest tyrian purple dye, manufacturers captured and crushed innumerable murexes, the remains of which were left to rot. (Experiments in 1909 yielded 1.4 grams (0.05 ounce) from 12,000 snails, and it takes around 200,000 to make a single pound of dye.) The precious purple mucous oozed out of the corpses and was collected by unfortunate workers until enough was produced to dye a garment. Since this (tightly kept secret) process was horrifyingly smelly (at best), whole sections of coast were given over to the industry. This inevitably led to the extreme reduction or extinction of these species.

Only a handful of individuals could afford the immense costs for this material (the exorbitant asking price, according to Aristotle, was 10 to 20 times its weight in gold and a pound of it cost three times the yearly wage of a Roman baker. To put that in perspective, today, as a baker, you can expect to have an average annual salary of about $22,000.) And sumptuary laws were passed proscribing the extent of to which it could be used.

Have students calculate: If you had 1lb of gold how much could you buy in ounces? How many yards would that be if a square yard of China silk weighs one ounce? If you had 30lbs of gold how much could you buy? How much would it cost at today's rate to buy 3 pounds? That could be one very expensive dress!

Historically, this dye was also called royal purple because kings, emperors, and high priests had the exclusive right to wear garments dyed with it. Tyrian purple was rumored to get brighter with each wash, as many ancient dyes lost their color very quickly.

But violet soon turned to violence. Legend has it that Emperor Caligula of Rome Caligula invited the Prince (Ptolemy) of one of the local Kingdoms to Rome and

Rediscovering Purple

The centuries-old recipe for Tyrian purple was lost to the Western world in 1453, when the Ottoman Empire conquered Constantinople. It wasn't until 1856 that the secret of purple was rediscovered, when Félix Henri de Lacaze-Duthiers, a French zoologist, saw a fisherman squirting a design on to his shirt using a shellfish.

In 1909, the Austrian chemist Paul Friedländer worked out the chemical properties of the dye and saw that it was almost the same as blue indigo, extracted from an Indian pea plant called *Indigofera tinctoria*. Indigo is also present in *Isatis tinctoria*, a member of the cabbage family – better known as woad. Woad, a popular dye for the Celts and Vikings, is now being used in ink cartridges for printers, because it is more environment-friendly than synthetic blue dyes.

In 1998, through a lengthy trial and error process, an English engineer named John Edmonds rediscovered the secret of how to dye Tyrian purple. He researched recipes and observations of dyers from the 15th century to the 18th century. He explored the biotechnology process behind woad fermentation. After collaborating with a chemist, Edmonds hypothesized that an alkaline fermenting vat was necessary. He studied an incomplete ancient recipe for Tyrian purple recorded by Pliny the Elder. By altering the percentage of sea salt in the dye vat and adding potash, he was able to successfully dye wool a deep purple color welcomed him with appropriate honours. As Ptolemy entered an amphitheater during a gladiatorial show, Ptolemy wore a purple cloak that attracted admiration. Out of jealousy, Caligula ordered Ptolemy's execution for having the audacity to sport a purple robe, making poor trendy Ptolemy possibly the world's first fashion victim. And, it started a war! After Ptolemy's murder in Rome, his former household slave Aedemon, from outrage and out of loyalty to his former master, wanted to take revenge against Caligula and started a revolt with his kingdom against Rome. The Berber revolt was a violent one and the rebels were skilled fighters against the Roman Army and it lasted four years.

The actual color is not what we would now consider purple, but rather a glorious rich burgundy (deep red) with purple undertones. The industry was destroyed when French aristocrats of the fourth crusade invaded and conquered Constantinople at the beginning of the 13th century. The bright, nonfading dye was never successfully produced commercially, and the secret extraction methods were assumed lost in the siege of Constantinople in 1453. The brilliant scarlet/purple hue was still in demand for the regalia of European kings and queens, but the available scarlet and purple dyes lacked the glorious richness and the famous colorfastness of Tyrian purple. During the middle ages, after the fall of Constantinople, royal crimson was obtained from insects and lichen. It was not until the great chemical revolution of the 19th century that purple clothing became available to everyone.

Marvelous Mollusk Mucus

A beautiful dye from a lowly mollusk? Today a well-dressed Mexican woman, might be surprised to learn that the brilliant purple of her dress required temporarily inconveniencing perhaps 1,000 snails.

Mollusks have been used in many parts of the world to obtain a purple dye. Ireland can produce archaeological evidence of dyeing with the native dog-whelk shells in the seventh century CE. Both Discorides, the Greek physician and Pliny the Elder, the Roman naturalist, mention in their first century works the preparation and dyeing of wool with various shellfish to produce colors of red, blue, purple and violet after first being mordanted with soapwort (Saponaria officinalis), oxgall or alum.

Coastal Indians of Mexico were also using shellfish, Purpura pansa, however, does not need to be killed to extract the dye. If one applies gentle pressure (tickling) to the foot of the mollusk the ink is released. This milky white liquid is dabbed onto a skein of cotton thread that the dyer carries wrapped around his forearm. The dyer then replaces the shell in a protected crevice where it will reattach and continue with its mollusk business.

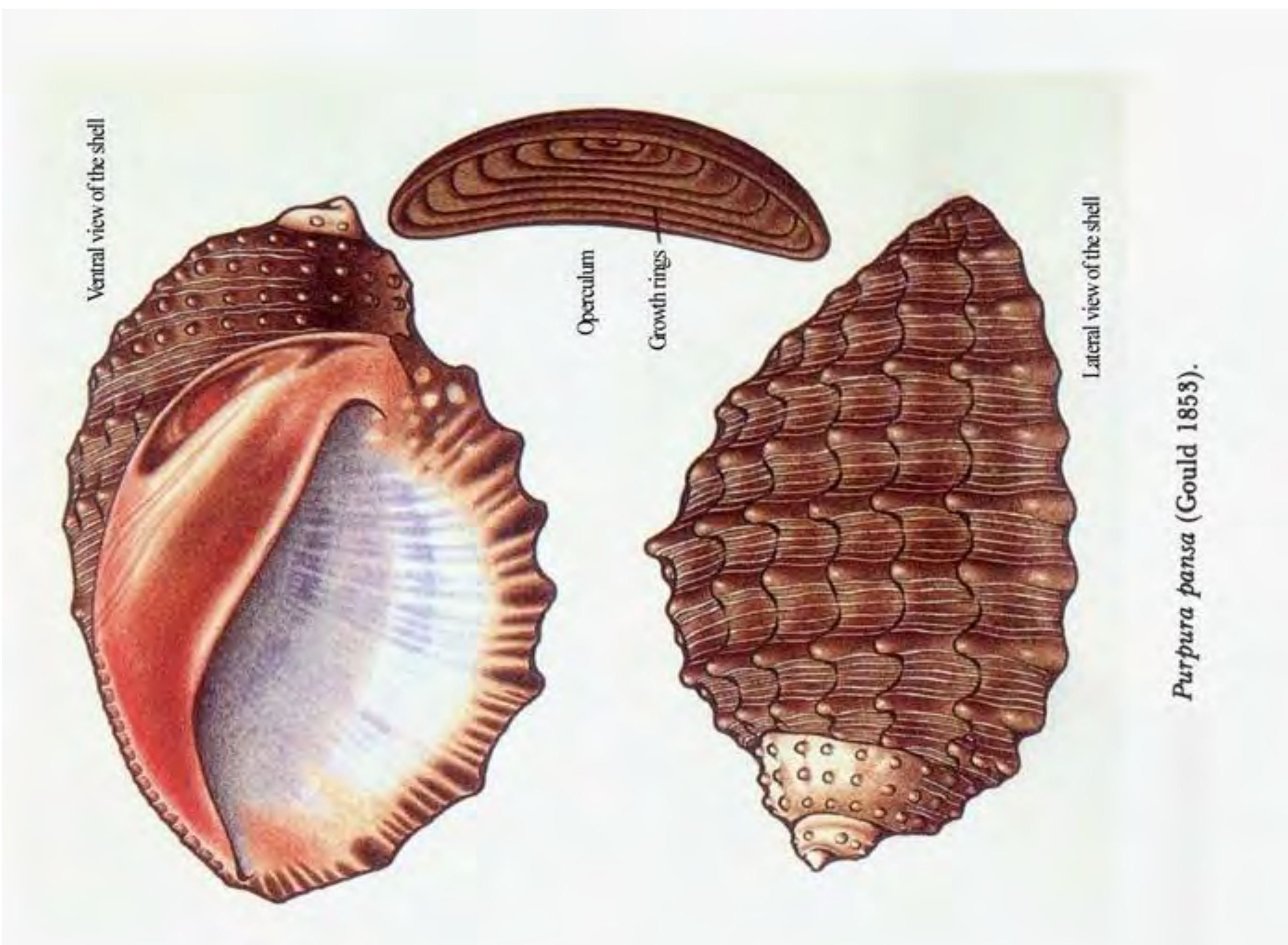
It is this simple fact, combined with the Mixtec dyers' deep understanding of the ways of Purpura panza, which have kept this species alive even to this day when wenty-five Mixtec Indian men, working along 30 miles of remote, rocky coastline in the Mexican Pacific, carry on an ancient tradition of dyeing cotton purple using the ink of small sea mollusks. They are the last traditional people on Earth who carry on this legendary practice using knowledge passed down them through the centuries by their forefathers. Each October, for untold generations, shell dyers from Pinotepa have headed down the coast in groups of five or six, walking 8 days, until coming to the rocky shoreline where these dye producing mollusks live among the crevices. The Mixtec call this animal Tucohoyi Tixinda. Western scientists have named it Purpura pansa. The dyers know, for example, that Purpura will regenerate its ink within one moon cycle, and so return to a given cove at most once every 28 days or so during the dyeing season. They only milk large, mature shells. They know that the mollusks mate in the summer and therefore only dye from October until March.

The dyeing is no fast process. It takes about 400 shells to dye one 12 oz. skein of cotton. And the dyers can only work about three hours a day. This is dictated by the tides. Purpura lives on rocks in the inter-tidal zone, so the shell dyers must work during low tide to reach them. These days a dyer is lucky to finish one skein a day.

Go through the following beautiful images of this traditional art and see what it's like to dye with one of the last ancestral Purpura (murex) dyers on the planet on the coast of Oaxaca.

Geographic distribution of *Purpura pansa* and the homologous species, *Purpura patula*, in the Pacific and Atlantic Oceans, respectively. (From El Caracol Purpura, pg. 77)

In Oaxaca it is found on remote rocky shorelines.



In real life it's a bit more disguised and hard to reach.

The indigenous people along the Oaxacan coast have carefully harvested the mollusk for thousands of years by plucking the shellfish off the rocks and using its ink to dye skeins of cotton thread. Purpura does not need to die to give dye. It is "milked" through pressure which causes it to release its ink. This is dabbed on the skein and the shellfish is put back on the rock.




A dyer may have to milk 400 hundred Purpura to complete a skein. By exposing the skein to sun and air the color turns from yellow to blue to a final and very fast purple. It also ends up dyeing the dyers hands.

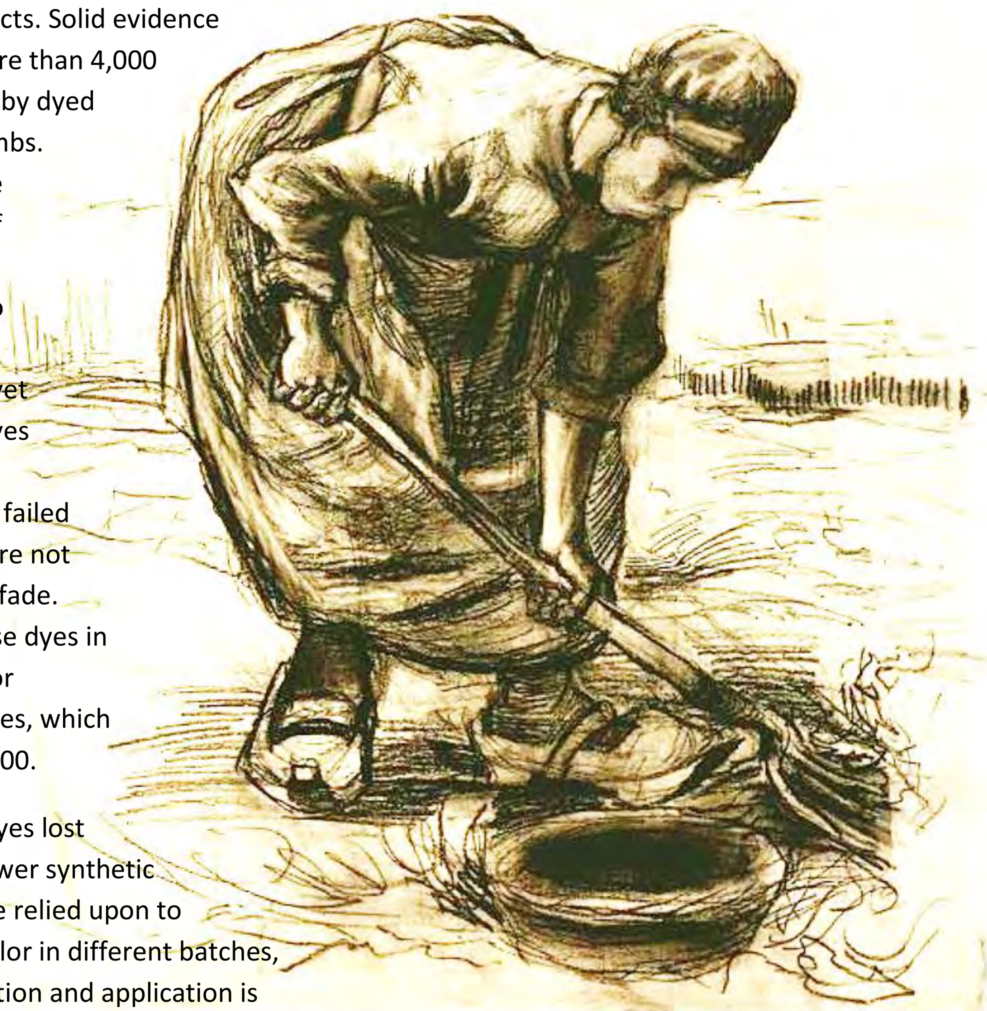
The finished skeins are taken into the village and sold to weavers to make traditional skirts which are the traditional dress of the women in the Costa Chica region of Oaxaca



Colors for the Common Man

While the powerful guild system had numerous dyestuffs with which to blend their color palates of fiber for the bluebloods and wealthy merchants, dyeing in the lower classes was a bit more restrictive. Without the money (or connections) to buy expensive dyes like cochineal and turmeric, clothing in the country tended to natural colors – whites, blacks, browns, grays, and tans of the natural colors of the fibers themselves, with the reds, greens and yellows of local plants used for both food, medicine and dyes. In short, home dyers used any plants they could lay their hands on that would give a good color. Some colors were even derived accidentally. Washing bee hives in preparation for making mead could yield yellows and golds. Blackberries and bilberries that stained the fingers of pickers could also be used to achieve pale blues and purples, although these were not often color or lightfast, meaning they faded quickly. In England, the multitudinous variety of lichens and mosses produced greens, grays and browns.

Until the 1850s virtually all dyes were obtained from natural sources, most commonly from vegetables, such as plants, trees, and lichens, with a few from insects. Solid evidence that dyeing methods are more than 4,000 years old has been provided by dyed fabrics found in Egyptian tombs. Ancient hieroglyphs describe extraction and application of natural dyes. Countless attempts have been made to extract dyes from brightly colored plants and flowers; yet only a dozen or so natural dyes found widespread use. Undoubtedly most attempts failed because most natural dyes are not highly stable and eventually fade. Nevertheless, studies of these dyes in the 1800s provided a base for development of synthetic dyes, which dominated the market by 1900.



Eventually, the old natural dyes lost popularity in favor of the newer synthetic ones. Natural dyes cannot be relied upon to produce exactly the same color in different batches, even if the process of extraction and application is standardized (done exactly the same way every single time) as with the larger dye suppliers. Since most natural dyes were imported from distant sources, transportation delays were likely to slow the production of dyed materials. Dye quality was affected by the whims of nature and the dye maker's skills. In addition, inefficient processes were often required for optimum results; for example, Turkey red dyeing could involve more than 20 steps to produce the desired bright, fast color.

By 1850 the Industrial Revolution in Europe led to a burgeoning textile industry, which created increased demand for readily available, inexpensive, and easily applied dyes that would give the same color every time.

As textile weaving technology advanced with the advent of machines to spin, design and weave fabric, dyers were forced to be able to produce dyes with exact shades, matching color lots and most importantly, ones that would stand "fast" to the new mechanical and chemical processing. In addition, exporters wanted colors that would stand up to tropical sunlight and still be exotic enough for foreign tastes. Dyers in turn demanded from their suppliers purer chemicals and dyestuffs of consistent quality. Dyers, manufacturers, chemists, and dyestuff producers worked hand in hand to keep up with the progress of technology. Chemists in many countries had found a means of extracting highly concentrated powders or pastes from traditional dyestuffs that made stronger colors.

By 1900 nearly 90 percent of industrial dyes were synthetic. By 1914 the synthetic dye industry was firmly established in Germany, where 90 percent of the world's dyes were produced. However, many who wore synthetic reds complained about the harmful effects of the arsenic from the dye that would leach into their skin and others complained of the harmful environmental effects on groundwater resource. For this reason cochineal production never quite faded away, despite the collapse of the major colonial projects.

W.H. Perkin, a student of celebrated European scientist Wilhelm von Hoffman, accidentally discovered the first synthetic dye in an attempt to synthesize quinine/make a fake or man-made type of quinine. Quinine is a white powder that is obtained from the bark of the cinchona tree that is found in the Andes mountain range of Ecuador and Peru. It was used as a medicine (It is in tonic water and Quinine gives this beverage its distinctive flavor. **Have students try it, ex. Schweppes tonic water.)** Quinine is still used to help prevent people from getting malaria and to help with muscle cramps. The destruction of these trees to obtain quinine made them rare and so a way of making it synthetically (or in a laboratory) was sought.

The 18-year old student's purple powder, later called mauviene (or mauve), was quickly put into industrial application, allowing the young Perkin to start his own factory in London to commercially produce his dyestuff. The success of mauve led to demands by English textile manufacturers for other new dyes. By trial and error other useful dyes were found. Two years letter a synthetic red dye called magenta or fuchsine was patented in France, and hardly a year passed until the end of the century without a new synthetic dye being patented.

By the end of the nineteenth century a few Scottish tweed producers were the only ones still using natural dyes, and now the use of natural dyes on a commercial scale barely exists, mainly in remote areas where people have either little access to synthetic dyes or a vested interest in retaining their ancient dyeing customs. In fact only one natural dye, logwood, is used commercially, to a small degree, to dye silk, leather, and nylon black.

Staying Put: The Science of Dye Retention

To fade or not to fade, that is the chemical reaction.

Earlier understanding of dyeing techniques and their applications was not backed by scientific reasoning. Natural dyeing had developed essentially as a folk art. However, in recent times the dyeing technique is interpreted on sound scientific principles, and the interaction between the dye and the fiber is well understood, whether the dye being used is natural or man-made.

In dyeing operations, the dye must become closely and evenly associated with a specific material to give level (even) coloring with some measure of resistance to moisture, heat, and light—i.e., fastness. These factors involve both chemical and physical interactions between the dye and the fabric. The dyeing process must place dye molecules within the structure of the fiber itself.

Dyes are classified (grouped) based on their structure, source, method of application, color, etc. The dye molecules can be anchored securely through the formation of covalent bonds that result from chemical reactions between substituents on the molecules of the dye and the fiber. (ex. the reactive dyes introduced in 1956) Various attractive forces play a role how well particular dyes work on specific fibers. The affinity of a dye for a given fiber is called its substantivity. Dyes can be classified by their substantivity, which depends, in part, on the nature of the dye molecules.

Attractive ionic interactions are key in the case of anionic (acid) and cationic (basic) dyes, which have negatively and positively charged groups, respectively. Like miniature magnets these charged groups are attracted to sites of opposite polarity on the fibre (North to South, and vice versa). Mordant dyes are a related type because mordants help form more highly polarized sites for better subsequent interaction with the dye molecules.

Modern day Dyes

Newer synthetic, or manmade, dyestuffs are classed as reactive dyes. Reactive means a chemical reaction takes place between the dye and the fabric molecules. The dye bonds with the cotton and becomes part of the fabric. That is why the dyes are so permanent and vibrant even after several washings. Reactive dyestuffs are chemically MORE reactive (makes sense)—they dissolve more readily in water, they bond more readily to whatever fiber they are used to dye (actually, they bond equally well to the water molecules themselves), and are, consequently, more substantive, less likely to bleed or fade with repeated washings and exposure to light.

These dyes are very popular now with crafters. They impart a greater degree of brilliance at surprisingly deeper and deeper shades of yellow, red, blue, green, brown, black, etc. whether used as individual dyes or as mixtures to obtain all hues (all colors) than all other natural or synthetic dyestuffs. Their use has been primarily on cottons. Little has been done to research or examine commercially the use of REACTIVES for dyeing wool. The method used in trial experiments and university research projects suggest the best technique for dyeing wool with REACTIVE dyes (as many of you have discovered on your own) utilize the same basic principles used for dyeing wool with conventional dyestuffs—from a weakly acidic bath at or near boiling. Acetic or Hydroxyacetic (Glycolic) or Formic Acid have been found to work better than simple vinegar because they are stronger.

Happy Atoms! Dating at an Atomic Level

So, just how do reactive dyes work? In order to really understand it, we need to think like atoms ourselves and play the Atomic Dating Game.

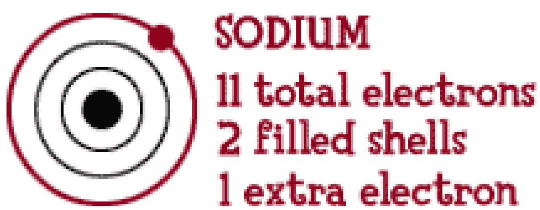
Atoms are lonely hearts that are constantly in search of partners to bring stability to their lives (at least for our purposes they are), as most atoms are unstable on their own.. Our job is to create as many long-lasting “couples” or molecules as possible from our eligible bachelors and bachelorettes and hopefully they last a long long time (we like our dyes to stay!)

Fiber Reactive Dyes are so called because they undergo a chemical reaction with the fiber during which they form a covalent bond to the fiber.

Let's first learn why atoms bond together. We'll use a concept called "Happy Atoms." We figure that most atoms want to be happy, just like you. The idea behind Happy Atoms is that atomic shells like to be full. That's it. If you are an atom and you have a shell, you want your shell to be full, but not TOO full. Some atoms have too many electrons (one or two extra). These atoms like to give up their spare electrons, they don't want to have to juggle so many. Some atoms are really close to having a full shell, but still have some room for more. Those atoms go around looking for other atoms who want to give up an electron.

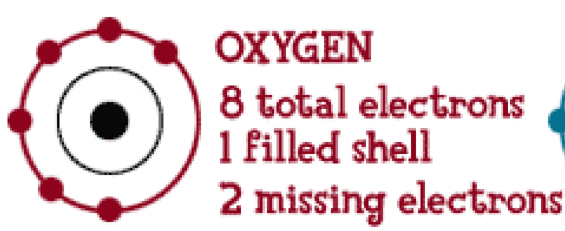
Let's take a look at some examples, our first bachelors and bachelorettes. We should start with the atoms that have atomic numbers between 1 and 18. IN order for them to be happy there is a 2-8-8 rule for these elements. The first shell is filled with 2 electrons, the second is filled with 8 electrons, and the third is filled with 8. Let's find a perfect match for the following atoms.

Draw and label the bachelor and bachelorette atoms on the board and have students draw them in their notebooks. Remind students we are not drawing atoms, but rather we are drawing models of atoms that are realistic in some ways and unrealistic in others. ***Then, one by one, match them up with their perfect date!***



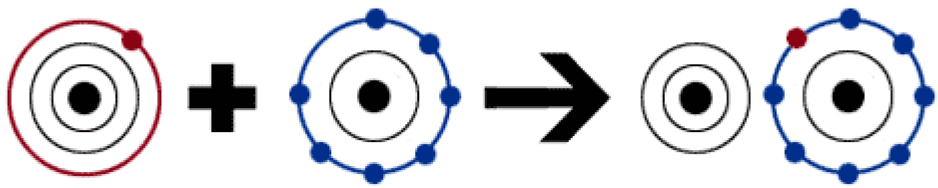
We can see that our Bachelors sodium (Na) and magnesium (Mg) have a couple of extra electrons. They, like all atoms, want to be happy. Ask about Sodium, "Are they stable?" They should tell you, no, and now you can ask why not. Once they've explained that he and Magnesium each need to lose electrons we set about the task of finding them suitable mates. They have two possibilities: they can try to get to eight electrons to fill up their third shell, or they can give up a few electrons be satisfied with a filled second shell. **Which would you choose?** It is always easier to give away one or two electrons than it is to go out and find six or seven to fill your shells.

What a coincidence! We have several Bachelorettes that are interested in gaining a few extra electrons.



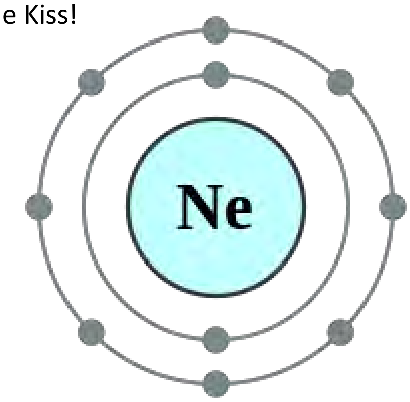
Oxygen (O) and fluorine (F) are two good examples. Each of those elements is looking for a couple of electrons to make a filled shell. They each have one filled shell with two electrons, but their second shells want to have eight. **Who looks like a good match? Who should date whom?** There are a couple of ways they can get the electrons. They can share electrons, sticking together and making a **covalent** bond, or they can just borrow them, and make an **ionic** bond (also called **electrovalent** bond). *When an atom chemically combines with another element, both atoms usually attain a stable outer shell consisting of 8 electrons.*

So, let's say we've got our Bachelor sodium atom that has an extra electron. We've also got our Bachelorette fluorine atom that is looking for one.



When they work together, they can both wind up happy! Sodium gives up its extra electron. The sodium then has a full second shell and the fluorine (F) also has a full second shell.

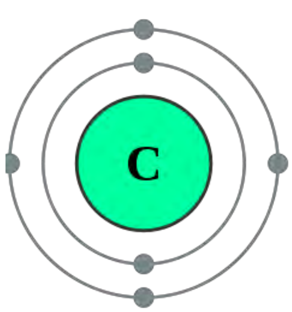
Two happy atoms! Draw our new compound with a big heart around it, choose a destination for the pair (like Cancun or the Bahamas), and then send them off with a big Dating Game Kiss!
Now we're ready for our next round!



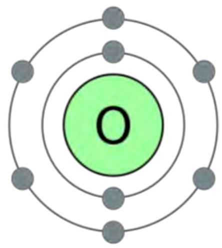
Bonus:

Ms. Neon (Ne) just showed up, does she need a date? *Once we draw her, we realize she is stable and doesn't require a match, (*perhaps she's *a modern Atom who doesn't need a man to fill her outer shell) and so we kick her out of the game.*

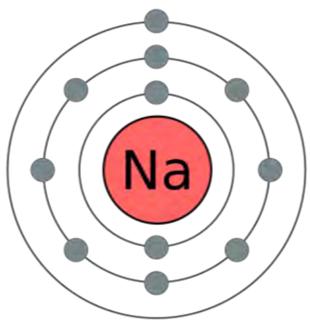
Bachelor Carbon (C)? Is he stable? Who might be a good match for him?



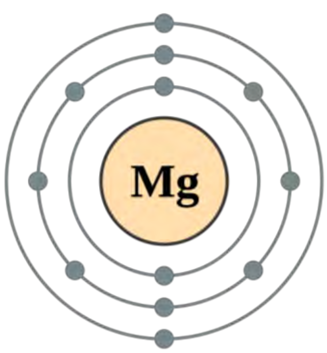
Oxygen (O): Who might be a good match for Bachelorette Oxygen?



Bachelor Sodium (Na)?



Mr. Magnesium (Mg)?



Mr. Magnesium has two electrons to offer, and since Ms. Oxygen needs two electrons, we've made a match!

Opposites Attract:

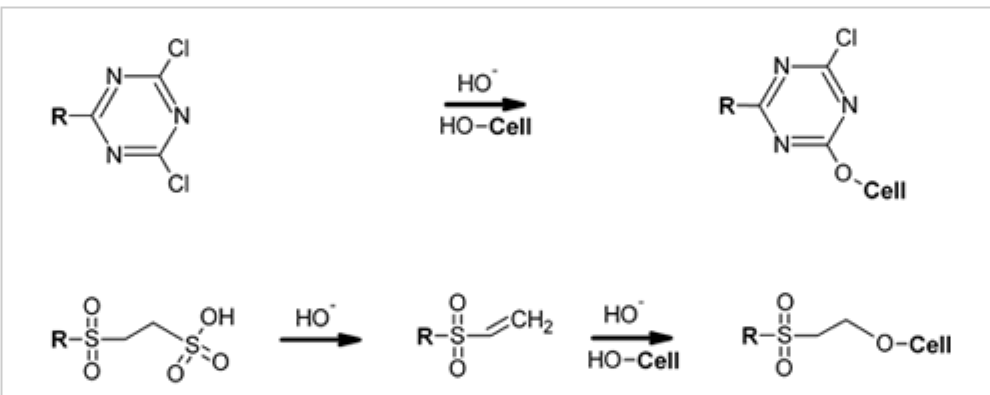
When an atom gives up an electron, it becomes positive like the sodium ion (Na^+). When an atom gets an extra electron, it becomes negatively charged like the fluorine ion (F^-). The positive and negative charges continue to make the atoms attract each other like magnets. The attraction of opposite charges is the way they form and maintain the bond. Any atoms in an ionic/electrovalent bond can get or give up electrons.

Kids often wonder about the shape of the periodic table, and when we discover that our bachelors can pair with several different bachelorettes from the same family, the kids construct their own understanding of the periodic table. Have fun with the game, but be sensitive to the cultural issues in your group. Issues such as dating, relationships, and television game shows can be sensitive topics. I*t is important to explain to students that The Atomic Dating Game only works for one-to-one pairings because it is a game show that creates one-to-one pairs.*

Now, back to the dyes.

Roll the Dyes

The dyes have a reactive molecular group on them that reacts with the hydroxyl (-OH) groups on of cellulose (plant) fibers, so they can be used on cotton, hemp, linen, rayon and other plant based fibers.



To speed the reaction and help the dye fix to the fiber, an alkali (acid) is used as a catalyst, rather like a Matchmaker that brings our Bachelor and Bachelorette together. For Fiber Reactive Procion Dyes the alkali used is Soda Ash. The alkali (acid/Matchmaker) helps our Bachelor get ready by stripping hydrogen atoms off of the cellulose molecules so that the dye can easily form the covalent (shared) bond with the Bachelorette oxygen in the hydroxyl (-OH) groups.

There is one drawback to this reaction, the hydroxyl groups are very much like water molecules which are H_20. The hydroxyl is willing to go on multiple dates at the same time, or even switch dates! The dye will start to form hydrogen bonds with the water if it is left to sit for too long. Once you mix up the dye it is best to use it within 24 hours.

While the reactive group is what makes it possible for the dye molecule to fix on to the fabric the main part of the dye that actually makes it appear a certain color is call a chromophore. When light hits a chromophore its molecular structure determines how is absorbs and reflects light. The reflected light from the chromophore is what we see as color. Different dyes have different chromphores and when we *mix the dyes on the fabric, the different wavelengths of light that each reflect back mix in our eyes. That is how we create different colors by mixing the dyes.*

Back in Black…and Every Other Color

However, due to the beautiful subtle tones that no chemical can reproduce, natural dyes are now well and truly back in vogue. For example, after chemical dyes were created the need for cochineal was almost eradicated. However, today, Peru supplies sixty percent of the world market. Demand has risen in the food and cosmetics industries, due to the carcinogenic (cancer-causing) factor recently identified in synthetic red colorants and an increase in allergic reactions to synthetic dyes, everything from skin rashes and headaches to breathing difficulties and even seizures.

Also, people have realized that synthetic dyes have an impact on water resources as it is estimated it takes over 75 gallons of water to produce only one pound of synthetically dyed cloth and the processes increase toxic outputs into the environment through waste products. We still haven't learned. **We still do the same thing today with everything from toys to diets**. **What are some other things that have been all the rage and then they said, never mind, it's not very good for us after all. Ex. fake sugars, olestra fat replacement (it was the wonder cure for fat, until it caused severe cramping, sudden diarrhea and increased people's chances for cancer, heart disease, stroke and blindness.)**

There is a large variety of plant, animal and mineral sources available today. Among these are lichen, twigs, berries, flowers, pecan bark, walnut husks(tans and browns), huisache seed husks(black), alfalfa and purul leaves(both give green), and "guaje" husks(reddish brown). The brown dye that comes from pecan shells is also made this way.

Using secret combinations, recipes and mixtures natural dyers once again conjure up an astounding array of colors and textures. These colors are the deep, vibrant tones of nature and are very long-lasting.

There is also renewed scientific and historic interest in natural dyeing, both to help identify dyestuffs in recently discovered archaeological finds and to preserve the dyed textiles housed in museums and private collections. As Su Grierson says in her book Dyeing and Dyestuffs, "Whilst the dyeing industry of today keeps pace with modern science, the future use of natural dyes will also follow a new path, but one firmly rooted in tradition."

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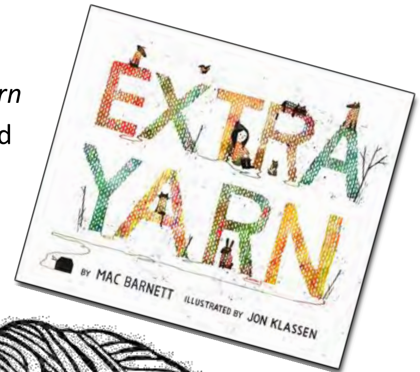
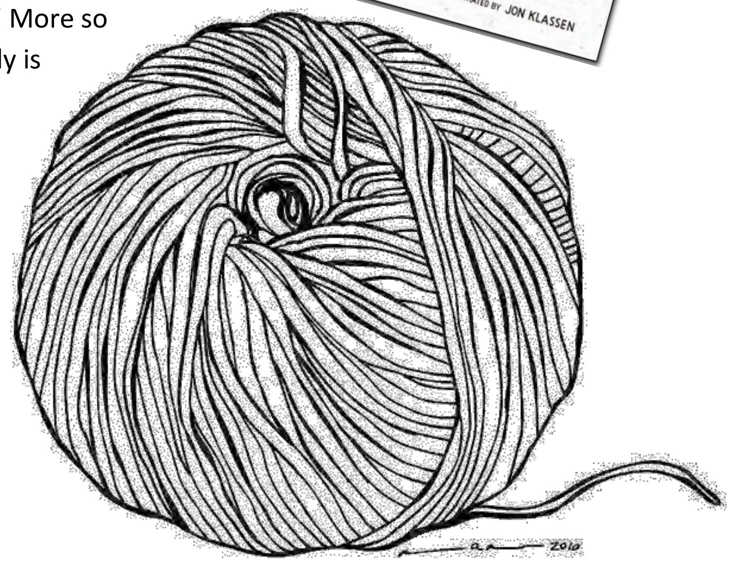
Fiber

Fibers

Introduce the topic with a fun fiber arts related children's book such as *Extra Yarn* by Mac Barnett, which was selected as one of the best picture books of 2012 and is up for the Caldecott.



People have been arguing about what art is since the days of Classical Greece and no complete definition has ever been established. And fiber artists face the same dilemma of all artists; determining "what is art?" More so with fiber arts, in that even if a particular potholder or doily is pleasing aesthetically, does that make it art? **What do students think art is? What makes something art?** Typically, pieces like potholders, which just follow patterns without doing anything more, are not considered works of fiber art. The two underlying questions about any work are: What makes this unique? What gives this value? Fiber art works are works of art that communicate some sort of message, emotion or meaning and go beyond just the literal meaning of the materials.



Fiber: From Necessities to the Necessary

Food, clothing, shelter – fiber has played its part in all three. Baskets for gathering and storing foodstuffs. Garments adorning the body. Quilts and blankets providing warmth in the winter; textiles making a house more of a home. Humans make fibers into useful objects by weaving, plaiting, and other ways of combining the various materials. Fibers for clothing are twisted into thread, and the thread is woven into cloth. The invention of these processes provided one of the foundations of civilized living.

When archeologists have explored dry caves, they've found that spun and woven artifacts outnumber stone artifacts by 20-to-1, with textiles dating as far back as 26,000 years ago. Traces of natural fibers have turned up in the remains of every single ancient civilization. Linen, made from flax plants, is at least seven millennia old, and was buried with Egyptians, as the wrapping of choice for mummified Pharaohs on their journeys to the afterlife. Cotton has been around, according to some, just as long, having been worn by Egyptian, as well as Chinese royalty. Merino wool is as old as the Stone Age, with fragments found in tombs and ruins throughout the Middle East, ancient Britain and Peru. Today 40 breeds of sheep account for 200 types of wool. Recent Chinese studies have found silkworms dating back 7000 years. Plant fibers – grasses, palm leaves, reeds, and the like, have provided abundant sources for fiber artists from around the world.

Did You Know?

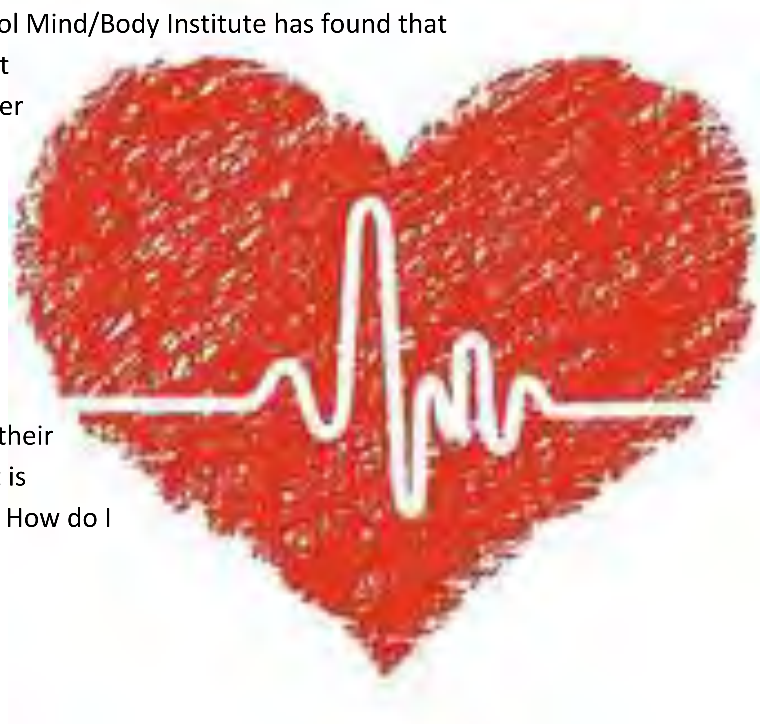
Fiber arts have been responsible for spurring the invention of other great things we use daily. For instance, it was the punch cards weavers used to set the patterns on their looms that got Charles Babbage and his partner, Ada Lovelace, (daughter of Lord Byron), working on a "calculating machine" in 1833, and later "the analytical engine", a predecessor of the personal computer. A few years earlier, English textile engineer Edwin Budding adapted the tool used to cut the nap off cloth to produce swaths of evenly trimmed grass that were becoming all the rage. In 1830, he patented the first lawn mower. There's no word on the opinion of the lawn grazing sheep it replaced.

Getting Down with the Beat

Be sure to make this into a Math activity!

Have students practice their estimation and calculation skills

Knitters and fiber arts can tell you how good it feels to work in their favorite craft. Now it seems it's good for you. It turns out that the repetitive actions needed for knitting and crochet can bring the mind and body to a state called a "relaxation response" that is quite similar to what people experience with techniques such as repetitive prayer, yoga, meditation, Tai Chi, and other relaxation disciplines. Research at the Harvard Medical School Mind/Body Institute has found that when an individual is knitting her heart rate can drop 11 beats a minute and her blood pressure drops as well. And knitting needles are a lot more fun than medical needles, so keep stitching!



Help the students locate their pulse points either on their wrists or necks. Ask students to place their right index and middle finger on the palm side of their left wrist. On the neck, the pulse point is located beneath the ear and jawbone. How do I find my pulse?

Count the number of beats in 15 seconds. Multiply this by four (15x4=60, there are 60 seconds in one minute). This is how many times the heart beats in one minute. Have students enter this "at rest" heart rate on their chart. (Student pulse rate at rest will vary between 60 - 110 beats per minute. Adult rates are lower.)

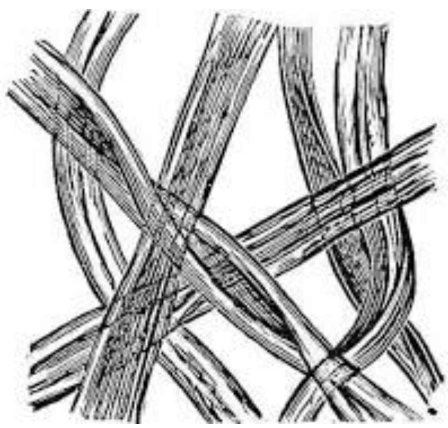
Compare the heart rates of students in the class by creating a chart. Are the heart rates the same or different? What about between boys and girls? By age?

What is the average heart rate of all the students? The average heart rate can be found by adding up the column of numbers of all the heart rates listed and dividing this number by the total number of students.

Have the students collect pulse rates from various adults and list this on another graph. Calculate the average heart rate for adults. How does this compare with the students' average heart rate?

Wool

Have kids hold and touch wool and guess what it is and where it is from. What animal does it come from?



Wool, a protein-based fiber, has been found in Europe dating back to 2000 BCE. It was a common medieval fabric in both dyed and natural colors, and was processed by both professional manufacturers and housewives. Wool is the fiber of a living animal, usually a sheep. It forms a protective covering that insulates against both heat and cold and keeps the animal's body at a consistent temperature. As a clothing material, wool does the same for people. It is light, comfortable, and durable.

Wool is the most complete fiber. It overtakes all other natural fibers even man-made fibers cannot compare to the natural capabilities of it. Some of wool's important advantages are: crimp, resilience, inflammable, absorbency, breathability, cleanliness, natural insulator.

FYI

The majority of wool that is used in fabric production comes from sheep, however there is a range of wools with more special characteristics than sheep wool like extra-softness, longer fiber, extra lustrous (shiny). These wools can be obtained from a variety of animals including goats, muskoxen, cashmere, vicuna, alpaca, camels, rabbits, etc. These breeds require special conditions to be raised making their fleece a luxurious (and more expensive) fiber to wear. **Pictures of each animal are included.**

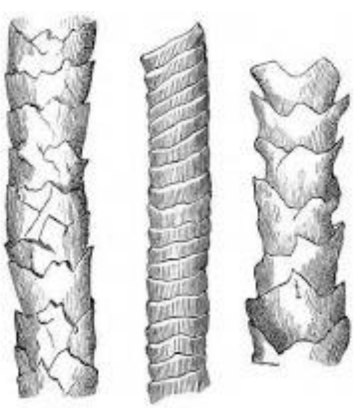
Crimp: Wool is a curly wavy fiber. The wave per unit is called crimp. Crimp adds elasticity, flexibility, resilience and loft. Crimp makes wool naturally elastic. It can be stretched to as much as 30 percent and will spring back to size when the tension is released. Once woven it will not stretch but will still shape and move with the body making clothing comfortable to wear.

Crimp allows wool to bend up to 20,000 times before it breaks, compare to the 3,000 cotton can bend or the 1,800 times that silk can do before breaking. This property makes wool garments durable, stronger and resistant to tearing. In addition, the crimp gives the fibers a built-in "memory" meaning that after being stressed or crushed they will spring back into their original shape unlike synthetic fibers.

Natural Insulator: The porous structure of the fiber explains why wool is such a good thermal insulator plus the crimp that holds each fiber apart from all the others, like curly hair creating volume that traps air, is a mesh of the fibers, which creates millions of air pockets that further help to regulate temperature and humidity - still air being one of the best insulators found in nature. Wool used in clothing will keep skin warm when it is cold and near body temperature when it is hot.

Absorbency has more to do with comfort than any other characteristic. Wool absorbs and wicks moisture keeping your skin dry it absorb up to 34% of their weight in moisture vapour without feeling wet, damp or clammy. The porosity of the cells in the outer layers of wool fiber allows them to quickly and efficiently wick and evaporate moisture. Moisture wicked away from the skin keeps the skin dry and comfortable and helps to prevent skin breakdown. This makes wool good for all climates since it aids in the body's cooling mechanisms to keep moisture away from the body.

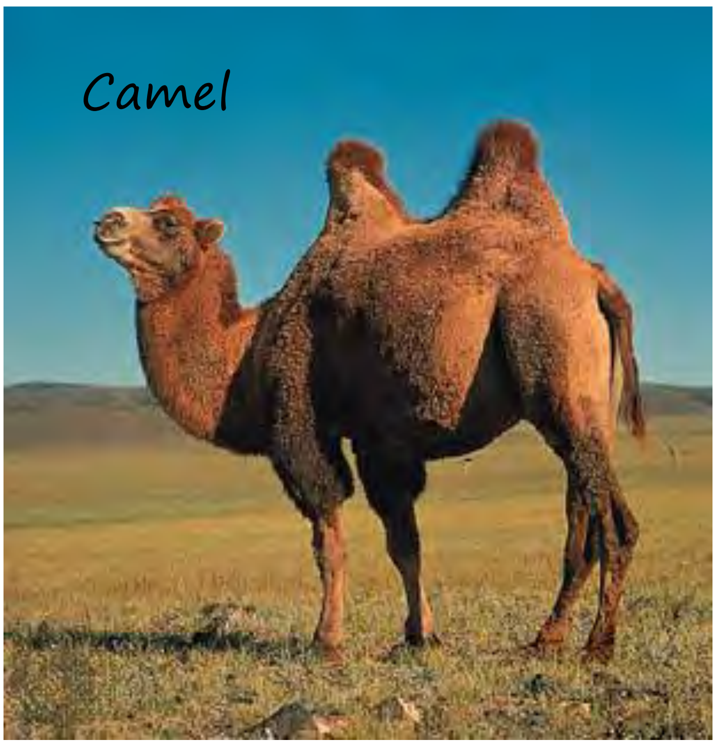
Inflammability: Wool contains 15% moisture in every fiber allowing it to resist flame. It ignites at a high temperature and is self-extinguishing; when flame is removed it puts itself out. Wool does not melt when burned, and so cannot stick to the skin and cause serious burns. Once a flame is removed, a cold ash is left. This can be brushed away immediately. Wool blankets are widely used to extinguish fires.



Cleanliness: When magnified under a microscope a wool fiber reveals interlocking scales that serve to repel moisture, lint, dirt and dust, making it easy to clean and inhibiting the growth of dust mites, mildew and bacteria.

- Wool shorn from sheep is totally **natural**, made of amino acids, the building blocks of life.
- Wool is **sustainable**. It runs on grass.
- Wool is **renewable**. Sheep can be shorn every 9-12 weeks.
- Wool is **biodegradable**. It breaks down to produce nitrogen, sulfur, carbon dioxide, and water, which are all plant foods.
- Wool improves air quality and balances the environment by absorbing vapor and releasing it.
- Wool is **healing** to humans. It does not give off harmful emissions. It is non-allergenic, it insulates, and protects...

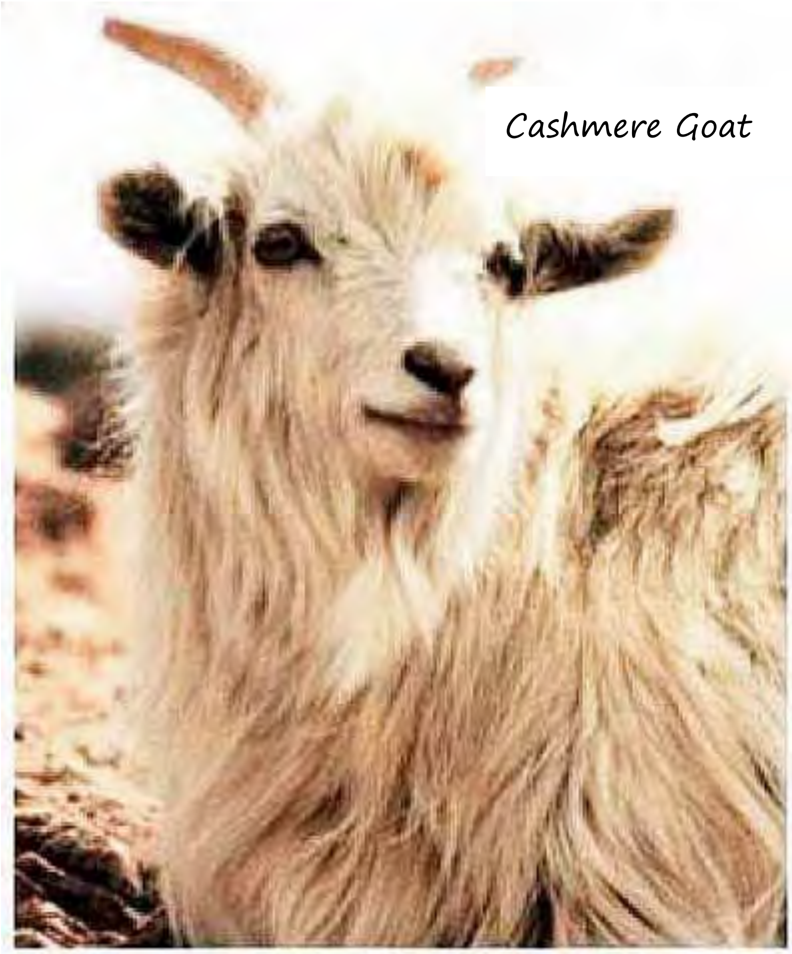
Angora Rabbit

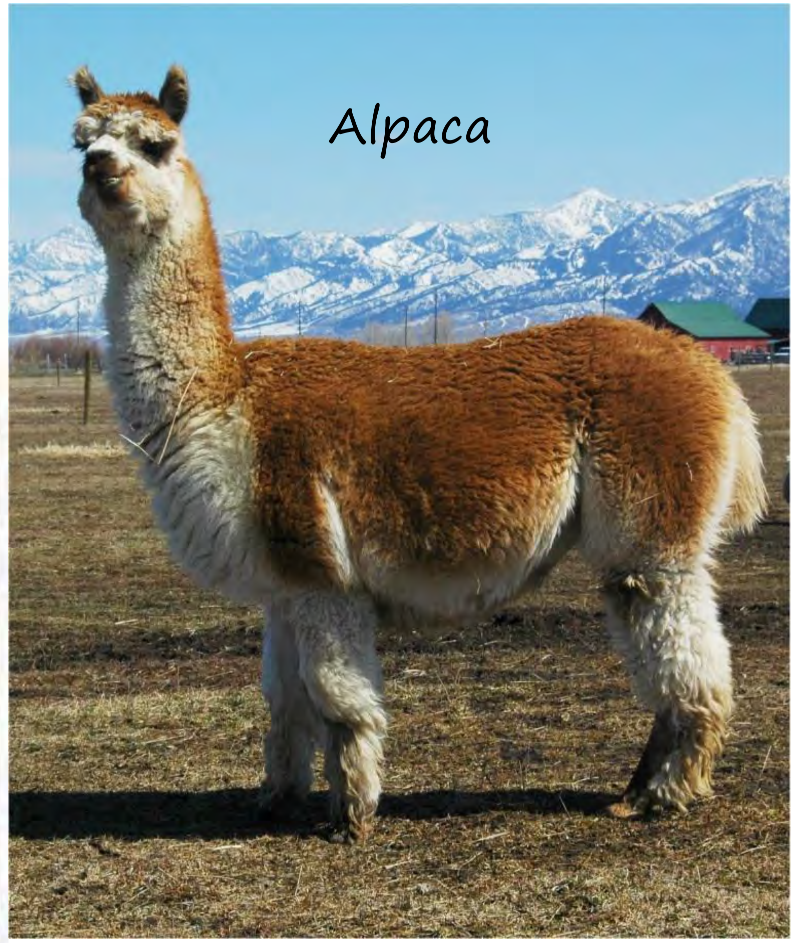


Camel

Vicuna

Sheep


Cashmere Goat


Alpaca


Musk Oxen

Spin a Yarn

Introduce children to oral story-telling as a way of strengthening their written literacy skills. Have students work together to weave story that could be passed down and told from one generation to another about The Mysterious Hermit Sheep of Terras (**Show students the pictures first without telling them the story of Shrek. What do they think? How did he get that way?**) Spinning is a process of teasing out fibers, intertwining them and stretching them out so as to produce yarn, or thread. Spinning a yarn is a process of working with fibers: stretching and teasing out fibers, combining threads, and spinning. These terms all match nicely to a description of the art of telling tall tales.

Where did the Hermit Sheep hide for so long? What did he do for those years? What must he have felt like under 15 inches of thick hair? What could be some funny things? What might the Hermit sheep have felt like if all his fluffy hair got caught in a bush? How might he have gotten out?

To start, create a story web using a ball of yarn. How?

1. Have the students sit in a circle
2. Begin a story, by contributing several sentences (even a paragraph or so, with older students).
3. Wrap the yarn around your hand one time, and then roll the ball of yarn to another person. (Demonstrate how to wrap the yarn loosely around the hand.)
4. That child adds to the yarn, and then rolls the ball to another student.
5. Continue until a complete story is told and everyone is holding one or more parts of the yarn, forming a web that connects the storytellers to each other, just as the storytellers in cultures around the world are connected.
6. Since children often want to go on and on with this story, the teacher may want to bring closure to the tale at the end.
7. Next, try to untangle the web by telling another story in reverse order so that the yarn is passed back eventually to the first speaker.

Shrek: The Famous Hermit Sheep of Tarras

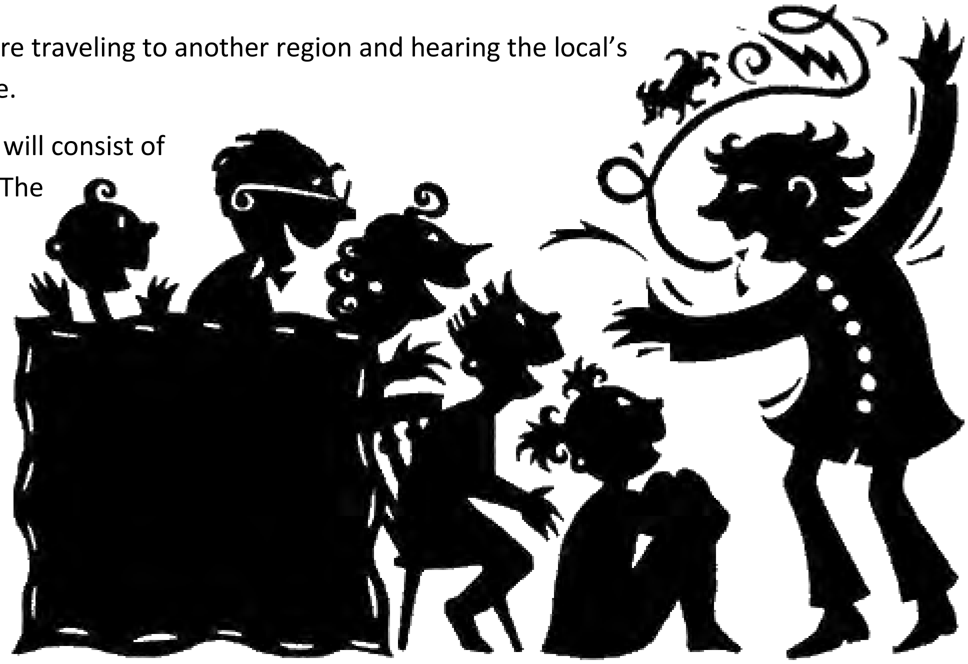
Shrek escaped from his enclosure of South Island New Zealand and then hid in caves for 6 years, never being shorn of his wool during all that time. When he was discovered in 2004, he was carrying 60 pounds of fleece (enough to make 20 large men's suits) which was sheered (The fleece, described as "rock hard" in places, was 38cm (15in) long) and auctioned for children's medical charities.

The 16-year-old sheep had a high-profile career. He was sheered by the World Champion sheep sheerer, met then Prime Minister Helen Clark, became the subject of several children's books and made regular charity appearances. His owner said he had an unbelievable personality. He loved children and he was really good with the elderly in retirement homes.

He died in the summer of old age and circulatory problems at age 16.

Gibberish stories

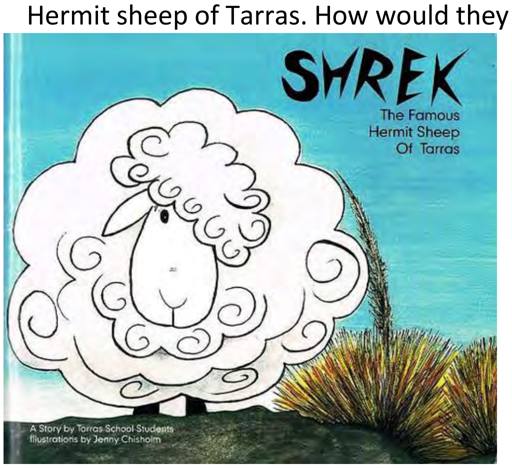
Now, students can pretend they're traveling to another region and hearing the local's tell Shrek's story for the first time.



Put the group in pairs. Each pair will consist of a storyteller and an interpreter. The storyteller must tell a story in gibberish, as if s/he were speaking a foreign language. The interpreter must then "translate" the story for the rest of the group. Make sure the storyteller understands that there is no "right" version of the story. The interpreter gets to make up the story as it goes along.

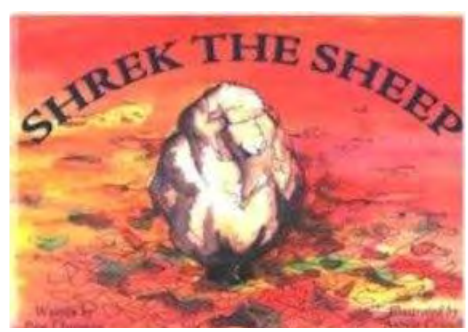
This activity is wonderful for demonstrating how much storytelling depends on elements other than language. For example, gesture, intonation, volume, facial expressions and so on give clues about what the gibberish story might actually be about.

Now, have students write down their favorite versions and elements of the different tales about the Hermit sheep of Tarras. How would they illustrate a book about what the Hermit sheep looked like?



Compare student's version of the story with the story by the Tarras school children about the famous sheep.

The story, written through a child's eyes, covers Shrek's start in life at Bendigo station, his journey to the mountains above, him finding a cave and making it home, and then his discovery and road to fame.



Then, compare and contrast your versions and the Tarras school childrens' version with the version by Pam Chapman, Shrek the Sheep: Based on a True Story, after reading it. How are they all similar? How are they different? Which do students prefer? Why?

People always want to "one-up" each other when telling a tale. If you caught a 10 inch fish, then mine was at least a foot! The same thing happens when it comes to wooly sheep, everyone wants theirs to be the wooliest! Read the following article with students and have students measure out 43cm (Taharo Trio) and 38 cm (Shrek). Which sheep was the wooliest?

Far better than Shrek!

*The southerners pulled the wool over our eyes with the story of Shrek - but **Lucy Reed** finds that when it comes to sheep yarns, Taharoa is in a flock of its own.*

MONSTER CATCH: Kawhia farmer Billy Black with two Shrek wannabes. PICTURE: Jeff Brass

Taharoa trio spin King Country's longest yarn

THIS is a woolly tale about four King Country farmers, four woolly sheep and a North vs South quest to find the longest yarn.

It started when South Islanders spun a tale about having the world's woolliest sheep — Shrek. Shrek will be shorn for the first time in up to six years by New Zealand shearing champion David Fagan live on TV tonight.

But the greater Waikato is laying claim to having three Shreks — dubbed the Taharoa trio. The first was caught in March as a practical joke for a local shearing competition.

Yesterday, four determined Kawhia farmers — Billy Black, Spencer Neal, Glenn Forde and Bruce Woods — set off into the hills to trap the last two of the Taharoa trio — allegedly the woolliest sheep in the world.

A short time later shouts were heard and the men emerged from the bush dragging two enormous, panting, woolly sheep. Even though the sheep couldn't see due to long dreadlocks over their eyes, Mr Black said they knew something was going on.

The men employed a decoy tactic where Mr Black and Mr Neal distracted the sheep, while Mr Forde and Mr Woods ran in to tackle them.

Mr Forde held on to the woolly mammoths as they somersaulted several times together down a wet bank.

Even after capture the sheep did not give in.

As Mr Black sat triumphantly with each sheep in a headlock hold, one of the friskier romneys decided to make a dash for it and dragged him before Mr Woods could come to his rescue.

The low-maintenance trio had lived without being shorn on the back-blocks of Mr Neal's farm for up to six years after they were missed in the muster.

The sheep caught in March had wool 43cm long, smashing claims made by southerners that they had the world's woolliest sheep, Shrek at 38cm. Mr Black was dubious as to the authenticity of Shrek. "I think it's a pet one. The South Island one was just a tourist sheep. This is a real North Island King Country sheep."

Mr Black plans to let the sheep dry out and then display them before he cleans them up and shears them.

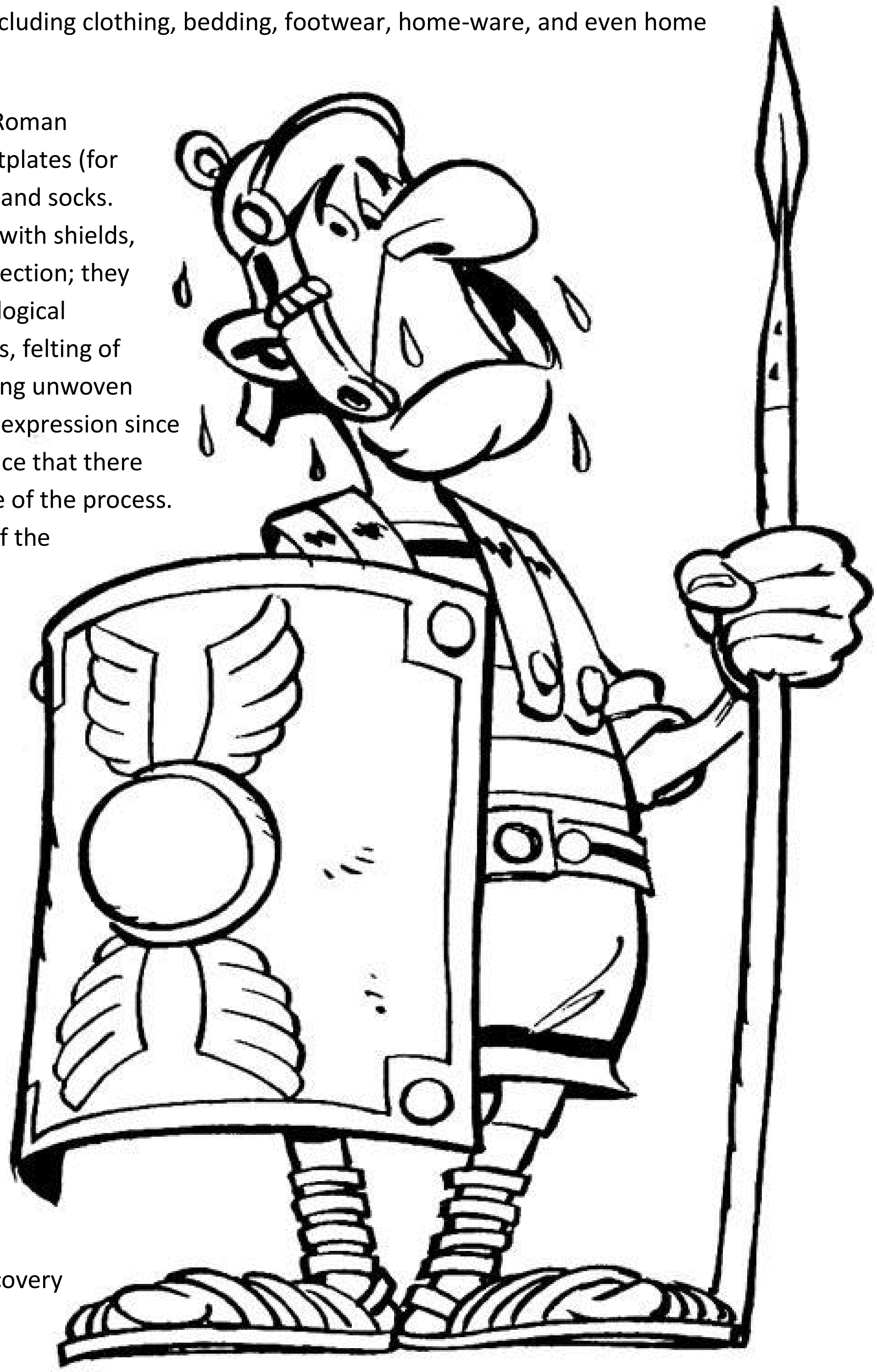
He believes he has a Super Shrek on his hands and the southerners' record is about to take an even greater beating.

Felt it Up!

As students work on wet felting projects, discussion of following should be incorporated throughout as part of the project.

Felting is an ancient practice of binding wool fibers into one whole. Felted wool is created and used all over the world for endless purposes including clothing, bedding, footwear, home-ware, and even home insulation. It is art with purpose.

The Romans and Greeks knew of felt. Roman soldiers were equipped with felt breastplates (for protection from arrows), tunics, boots and socks. China's warriors equipped themselves with shields, clothes, and hats made of felt, for protection; they also used felt boats. Based on archaeological findings from the Central Asian Steppes, felting of animal hair has been a means of creating unwoven fabric for clothing, shelter, and artistic expression since at least 600 BC. There is further evidence that there may have been even earlier knowledge of the process. Today felt is still in use in many parts of the world especially in areas with harsh climates. In Mongolia, nomads live in felt tents called yurts or gers. In Turkey, rugs, hats and other items are made of felt. In South Central Asia nomadic tribes use felt as tent coverings, rugs and blankets. Shepherds use felt cloaks (kepenek) and hats to protect them from the harsh climate. In Scandinavia and Russia, felt boots are produced and widely used.

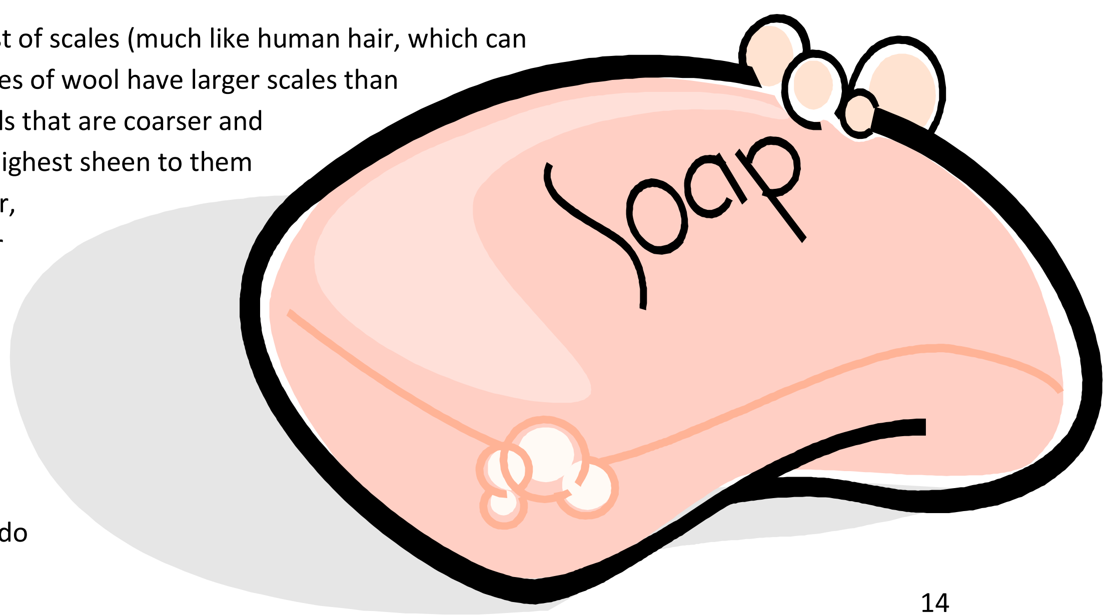


Since wool felt is not woven and doesn’t require a loom for its production, it can be made rather easily. Because of this, felt is the earliest known form of fabric. The true origin of felt is unknown, though several cultures take credit for the discovery of felt. One Sumerian legend tells of Saint Clement, a wandering monk, who cleverly wrapped flax fibers between his shoes and feet to prevent blisters. Upon arrival at his destination, he removed his shoes and discovered that the flax had, in fact, felted due to the heat, pressure and perspiration. Saint Clement became the patron saint for hat makers. Others say it was a nomad who placed fleece under his saddle so not to blister his horse. What they both have in common is through moister, heat and friction felt was created. Through time it would also be discovered that when felted enough the fabric repels water, keeps dry and warm in the winter, dry and cool in the summer, and fireproof.

Magnified wool fibers have the appearance of scaly worms.
Courtesy, American Wool Council

Felt is a mass of dense wool and/or fur. It is not woven, but rather pressed and manipulated in a centuries-old process using heat, moisture and pressure or agitation. The result is the strongest, smoothest, most water-resistant natural fabric known. Soap helps in the felting process.

Wool fiber strands consist of scales (much like human hair, which can also be felted). Some types of wool have larger scales than others. The types of wools that are coarser and smoother and have the highest sheen to them (such as Lincoln, Leicester, Wensleydale) have larger scales and reflect more light off their surface leading to the sheen. Finer wools (of which Merino is the main example) have much, much smaller scales and do



not reflect light and have a more "matte" look to the surface of the yarn or finished knitting.

The advantage of using fine animal hair, like wool, is that it will form a dense, even mat, the individual fibers becoming indistinguishable. Coarser hair, like human hair, will not form as nice a felt as wool, but it will felt. That's what dreadlocks are.

These scales tangle together when carded wool (combed un-spun wool, also called roving) is laid across itself in different direction, moistened with water, and massaged (a bit of soap is added so that this process is easier). After the strands are tangled the fulling stage completes the felting process (imagine miniature Velcro swatches connecting to each other). During this fulling stage heat and more friction is applied. This is the stage in which the wool piece begins to shrink and becomes stronger. As the heat is applied the scales open again, the friction causes the strands to stretch, but like a rubber band they retract and tangle even more with one another. Repeating the heat and friction several times allows for the wool to felt completely, shrinking to about 40% of its original size.

When wool fibers are shocked by temperature and rubbing the little scales lift up and as the fibers rub against each other they lock down on nearby fibers and form a tighter and tighter mass and form felt. Felt can be made from "just the fibers" unspun, or as many knitters are discovering, from knit pieces that are felted after knitting. Heat and moisture cause the outer overlapping scales along the wool fiber to open, and the soap allows the fibers to slide easily over one another, thereby causing them to become entangled. Wool fibers are made up of a protein called keratin. The keratin in the fibers becomes chemically bound to the protein of the other fibers resulting in a permanent bond between the fibers.

Additional fibers that alone would not felt, such as silk and cellulose, can be added in small proportions to the felt, as the animal fibers will intertwine and mat around them.

While machinery can be used today to accomplish many of these tasks, the processing requirements remain unchanged. One exception is that until the late nineteenth century mercury was used in the processing of felt for hatmaking. Mercury was discovered to have debilitating effects on the hatter, causing a type of poisoning that led to tremors, hallucinations and other psychotic symptoms—hence the term “mad hatter.”

The felting process is irreversible. Sometimes this is unfortunate! Many unhappy owners of fine wool sweaters have discovered felting by accident when a (usually well-meaning) mate or child dumps a wool sweater into the washing machine and out comes a much smaller, thicker sweater.

Superwash wool is a wool that has been treated by one of several processes or surface treatments that smooths or "glues down" the little scales on the wool so that they do not lift up and lock down on neighboring fibers. Some treatments are more stern and really lock the fibers (with often a textile "glue" made from a nylon type solution that will dye similarly to the wool) and these treated wools can go through both a washer and a dryer. Most Machine Wash yarn labels, however, mean you can do a gentle wash cycle, but dry flat and NOT put in the dryer.

Felting Rocks!

There are different ways of making stones, but this an easy method that gives good results from Lisa Jordan at http://lilfishstudios.blogspot.com/2012/02/how-to-make-felted-stone.html.

What students will need:

- Small stones
- wool roving
- Optional: a felting needle (to be used by instructor
- an old clean towel
- a bowl
- soap (I use dish soap)
- a plastic bag
- access to hot and cold water

To start, have students fluff out their roving and pull wisps of it off. Lay these wisps down with the fibers laying in the same direction, slightly overlapping, until they have a mat of fibers forming on the table.

Lay these wisps down with the fibers laying in the same direction, slightly overlapping, until they have a mat of fibers forming on the table.

The mat should be slightly wider and roughly 3 times longer than the stone. The bottom of this first layer will be what you see on the outside of your finished stone so it should be as uniform as possible.

Add a second layer of wool with the fibers laying perpendicular to the first layer. Press down on the mat you've made. If you can feel gaps or if the mat feels unusually thin, add a third layer, again running perpendicular to the layer beneath it.

Lay your stone on the fiber mat. If your stone has a definite top and bottom, position it with the bottom side up.

Fold the wool up and over the stone and roll the stone over one time, keeping the wool taut as you roll. After this first fold, the top of your rock should be facing you.

Fold the side pieces up and over the top of the rock. These sides will pad the top of the stone, giving it a slightly thicker surface than the bottom. This helps the stone sit nicely once felted.

Continue rolling the rest of the wool over the rock, keeping the wool taut but not so tight that you pull fibers out of the mat.

If you don't have a felting needle, you could take the stone right to wet-felting at this point.

If you do have a needle, even out the fiber at each end of the stone until you can no longer see where the fiber was rolled.

Fill your bowl with hot water and add a drop or two of soap. Dribble water over the stone gently until all of the wool is wet.

Carefully move the wet stone from one hand to the next, sort of like you're playing catch. You want to treat it gingerly until the wool fibers start to pull together.

Dip the stone back in the water from time to time to keep the wool warm. You can also add a tiny drop of soap to your hands as needed and keep rolling the stone gently.

Once the wool starts to hold together a bit, you can start to add a little more pressure. You'll want to be careful not to rough up the surface of the stone, but rather to get those fibers to bind together around the stone.

Once the wool has felted around the stone pretty securely (if you can pinch the wool and separate fibers from the mat, it's not ready yet, keep working) grab your plastic bag.

If the bag has a logo printed on it, make sure to turn this to the inside so the ink doesn't transfer to your stone. Wet the bag, fold the stone up inside it, and rub. This is where you can add some real pressure to the stone. The tiny folds in the plastic bag act as a gentle washboard but the smooth surface keeps the wool from getting scruffy. Rub and roll the stone with the bag until the wool is firmly felted.

Immediately rinse the stone under very cold water (or dip it in a bowl of ice water) while rubbing it with the plastic bag. This will help the fibers lay down nicely.

Lay the wet stone on the towel and leave it to dry. Don't try to force water out of it with a towel, just leave it alone. It's a good idea to use an old towel or a rag as some dyed rovings can leach some color while drying.

Once your stone is completely dry, you can trim off any stray fuzz with a pair of scissors. And there you have it! A stone cocooned in soft wool. Oh the possibilities.

Do keep in mind that some wool felts better than others. Roving marked "superwash" isn't going to wet-felt for you. Sometimes undyed wool can be harder to felt as well. Some wools like shetland have a scruffier surface.

History of the Fibers Themselves

Since the difference in fibers has been mentioned, it would be remiss not to spend a moment on the historic nature of the fibers themselves. Wool, a protein-based fiber, has been found in Europe dating back to 2000 BCE. It was a common medieval fabric in both dyed and natural colors, and was processed by both professional manufacturers and housewives.

Silk, another protein-based fiber, was imported from China to Persia as early as 400-600 BCE. It became quite popular in the Late Middle Ages, and major silk manufacturing centers were set up in France, Spain and Italy. These silk production centers also became centers of dye technology, as most silk was dyed and required the highest quality dyes available.

Cotton was considered a luxury fabric, as it was imported all the way from India and usually dyed or painted before it was shipped. Cotton was also valued because of the brightness and colorfastness of the dyes used to color it, and also for its use in making candle wicks. Samples of cotton fabrics have been found in India and Pakistan dating to 3000 BCE, but it did not appear in Europe until the 4th century. Cotton weaving establishments were formed in Italy in the 13th & 14th centuries but they did not make a significant economic impact on the industry as they produced a coarser quality of fabric than the imported fabric, and therefore had difficulty in obtaining a good supply of cotton fiber.

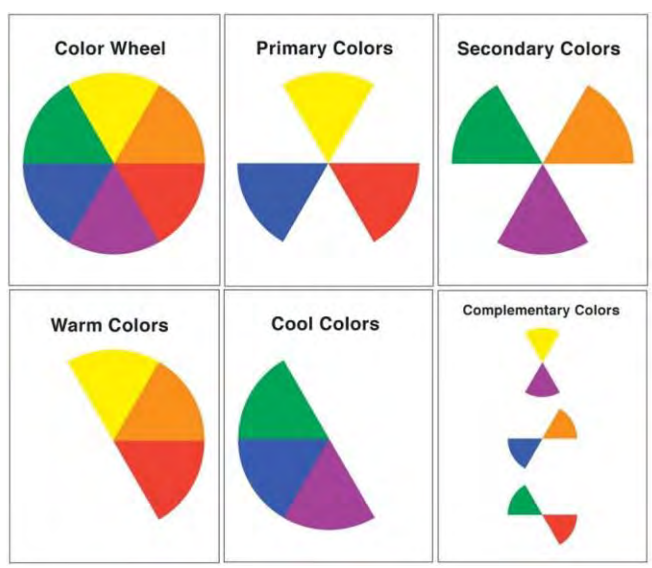
Scientists are almost certain that dyeing was practiced throughout the world, but it is difficult to obtain proof on this for two reasons. First, not all cultures left written records of their practices. Second, because of the wide variance of environmental conditions and degree of geological disturbance, it is not easy to find well-preserved evidence of dyed textiles in many archaeological sites. A Chinese text from 3,000 BCE lists dye recipes to obtain red, black and yellow on silks. Ancient Indian texts describe several different yellow dyestuffs, how to obtain reds from the wood and bark of certain trees, and also notes the use of indigo to create blues on cotton. In Central and South America they dyed bast fibers (plant fibers) in shades of red and purple with the bodies of the cochineal insects (Dactylopius coccus).

Choosing Colors

Introduce the topic with a book like *Pantone: Colors*. Inside the dynamic cover reveals 9 wonderful colors and their glorious shades. Help students explore the concept that one color name actually refers to a variety of dark, light, and in-between tones. Have younger children begin by simply naming the colors of the monochromatic images, they will soon grow to select their favorite and least-favorite shades. *Pantone: Colors* is a visually pleasing way to expand the colors conversation and develop a child's sense of visual discrimination.

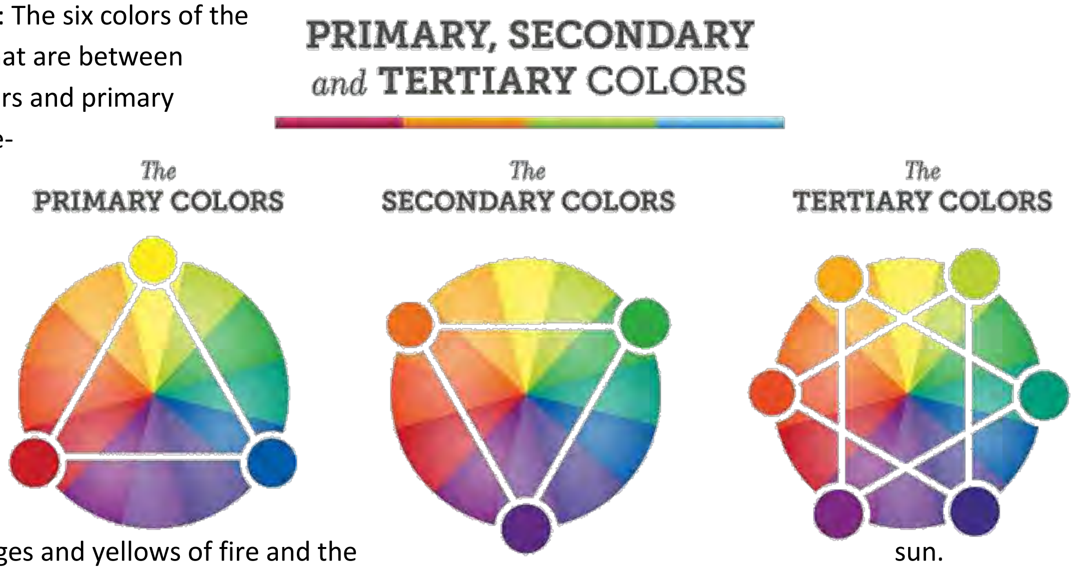
Pantone Inc. (a wholly owned subsidiary of X-Rite, Inc.) is the world-renowned authority on color. For more than 45 years Pantone has been inspiring design professionals with products, services, and technology for the colorful exploration and expression of creativity. In 1963, Lawrence Herbert, Pantone's founder, created the Pantone Matching System, a book of standardized color in fan format-an innovative system for identifying, matching and communicating colors to solve the problems associated with producing accurate color matches in the graphic arts community. Pantone has since expanded its color matching systems to include other color-critical industries including digital, fashion, home, plastics, architecture, interiors, and paint. Today, the Pantone name is known worldwide as the standard language for accurate color communication.

Color is one of the fundamental elements of our existence, and defines our world in such deep ways that its effects are nearly imperceptible. Color is also one of the fundamental elements of art. It is important for art students to not only be exposed to color theory, but to understand it. Color theory is central to understanding and creating art.



The concepts of color theory include the color wheel, color values, and color schemes. Color Theory is a set of principles used to create harmonious color combinations. Sir Isaac Newton developed the first circular diagram of colors in 1666. Since then scientists and artists have studied and designed numerous variations of this concept. Differences of opinion about the validity of one format over another continue to provoke debate. In reality, any color circle or color wheel which presents a logically arranged sequence of pure hues has merit. Color relationships can be visually represented with a tool called a color wheel — the color spectrum of light wrapped onto a circle. H**ave students look at their fiber swatches they dyed earlier or available pre-dyed fiber swatches and determine which ones belong in each category as you discuss them. You may want to have students work as groups to divide the colors into groups, sort and get rid of duplicates. After that, as you discuss have students group colors as a class into warm, cool, and neutrals and glue tiny samples of each of them to a large poster under each heading and/or form them into a wheel.**

- Primary Colors: The three main colors of the color wheel (blue, red and yellow) from which all other colors are made. In traditional color theory, these are the 3 pigment colors that cannot be mixed or formed by any combination of other colors. All other colors are derived from these 3 hues.
- Secondary Colors: The three colors of the color wheel that are midway between two primary colors (orange, green and purple).
- Tertiary Colors: The six colors of the color wheel (that are between secondary colors and primary colors (i.e. blue-green). These are the colors formed by mixing one primary and one secondary color.



- Warm colors: The reds, oranges and yellows of fire and the sun.
- Cool colors: The blues and greens of sky and sea.

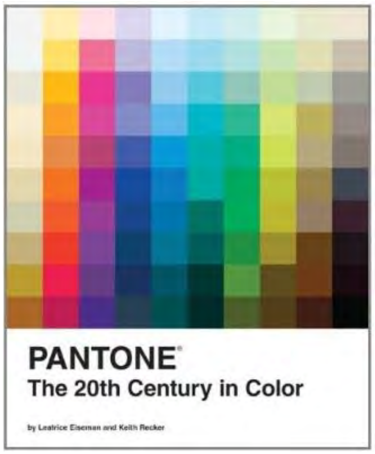
Now, what about those non-color colors we talked about? When you add in white and black, you get a whole new element and some new terms.

- Value: Whether a color is light, medium or dark.
- Hue: A pure color to which nothing has been added.
- Chroma: Bright or dull
- Tint: A color to which white has been added to make it lighter.
- Shade: A color to which black has been added to make it darker.

- Tone: A color to which its complementary color (or gray) has been added to mute it.
- Contrast: A visible difference in value and/or color.

Choosing Colors

Color influences our lives and world events influence our color choices. Continue this topic with a color book such as Pantone: The 20th Century in Color (Chronicle Books), that looks at how color and cultural history affect each other. Discuss with students why certain colors might become popular. What is happening in society literally colors our lives, through upholstery, wall paint, rugs, and other textiles and accessories.



To choose our own colors in our fiber arts it works best when we become familiar with the color wheel = and the placement of colors on it. Also, students need to become familiar with the color schemes below. **This will help them to choose colors that enhance each other for their projects in each strand (fiber and silk).**

One of the best ways to choose a color scheme is to choose something (i.e. a picture or print fabric) whose colors you like and make a color scheme from that.

> **A Blast of Color!**
> PBS' web-series Off Book has been at the forefront of online, educational, and geeky programming. A new episode recently went live, and it's a compelling and brief introduction to color.
> Delving into color theory, physical and psychological responses to color, color preferences through history and more, it's a lot of information in under eight minutes. They talk to Thomas Bosket of the Parsons the New School for Design, Leslie Harrington of the Color Association, Doty Horn of the Fashion Institute of Technology, and GIF makers Mr GIF.
> Get ready to have your senses sharpened by a blast of color by watching the video here http://video.pbs.org/video/2293574270/ or http://www.popphoto.com/news/2012/10/pbs-tackles-color-theory-mini-episode.

Another good way to choose a color scheme is to draw the project on the computer or graph paper and color it in with colored pencils till you get one that you love. Do students notice that dark, cool colors seem to recede (move backwards) while light, warm colors tend to advance toward you? Take note of the way that colors placed side by side can often create new secondary patterns when colored creatively.

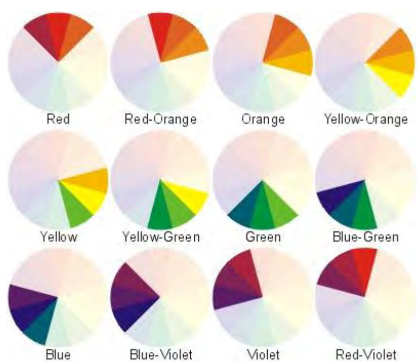
Please note that good color schemes are rarely made from the simple hues of each color. For example, the popular color scheme of pink and green is actually a complimentary color scheme using a tint of red (pink) and tones of green (usually sage or mint). The popular combination of blue and peach are actually a tone of primary blue and a tint of orange. When choosing a color scheme, encourage students to look beyond the simple hues and consider variations of the colors in question.

Harmony can be defined as a pleasing arrangement of parts, whether it be music, poetry, color, or even an ice cream sundae. In visual experiences, harmony is something that is pleasing to the eye. It engages the viewer and it creates an inner sense of order, a balance in the visual experience. When something is not harmonious, it's either boring or chaotic. At one extreme is a visual experience that is so bland that the viewer is not engaged. The human brain will reject under-stimulating information. At the other extreme is a visual experience that is so overdone, so chaotic that the viewer can't stand to look at it. The human brain rejects what it cannot organize, what it cannot understand. The visual task requires that we present a logical structure. Color harmony delivers visual interest and a sense of order.

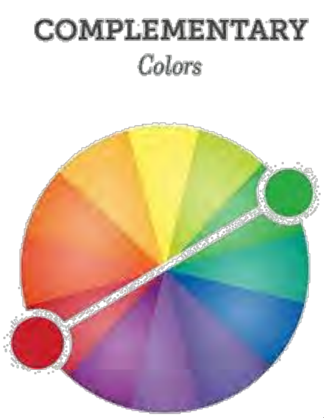
Classic Color Schemes

When you know how to use it, the color wheel can be a wonderful tool for art, or even putting together outfits!

Analogous Color Scheme



Analogous colours are any three colours which are side by side on the colour wheel, such as blue-green, blue, and blue-violet and create more harmonious and more subdued look. One color is used as a dominant color while others are used to enrich the scheme. The analogous scheme is similar to the monochromatic, but offers more nuances.



Complementary Color Scheme

The complementary color scheme consists of two colors that are opposite each other on the color wheel. When placed next to each other, complements make each other appear brighter. This scheme looks best when you place a warm color against a cool color, for example, red versus green-blue. This scheme is intrinsically high-contrast. These opposing colors create maximum contrast and intensify one another more than they would appear separately.

Split Complementary Color Scheme

The split complementary scheme is a variation of the standard complementary scheme. This is a color scheme that includes a main color (in the ex. blue) and the two colors on each side of its complementary (opposite) color on the color wheel (red orange & yellow orange). This provides high contrast without the strong tension of the complementary scheme.

Monochromatic Color Scheme

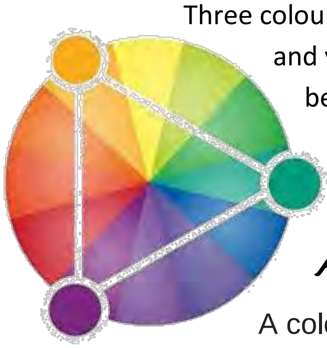
Monochromatic colors are colors in the same color family and are a simple way of color coordinating. The monochromatic color scheme uses variations in lightness and saturation (tints, tones, and hues) of a single color. *Think of a paint chip, that is a monochromatic series.* You may think that using only one color will get really boring. You would be surprised how many variations, both obvious and subtle, can be achieved from just one color.

- some **white** to get lightest Tints
- tiny drop of **black** to get darkest Shades
- a little **gray** to Tone things down
- more **of the original hue** to increase color intensity

This scheme looks clean and elegant. Monochromatic colors go well together, producing a soothing effect. The monochromatic scheme is very easy on the eyes, especially with blue or green hues.

TRIADIC
Colors

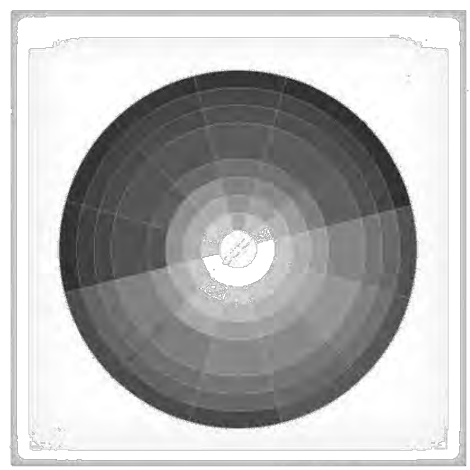
Triad Colours



Three colours that are 120 degrees apart on the colour wheel. The primary colours red, blue and yellow are examples of triad colours. This scheme is popular among artists because it offers strong visual contrast while retaining harmony and color richness.

Achromatic Color Scheme

A colorless color scheme using blacks, whites, and grays. These colors are not on the color wheel. The achromatic color scheme uses variations in lightness and darkness of black, gray and white. This scheme depends on contrast. It also looks clean and elegant but produces a stark, harsh effect, often meant to portray surrealism. Sometimes just a dash of one color is added as an accent.



achromatic

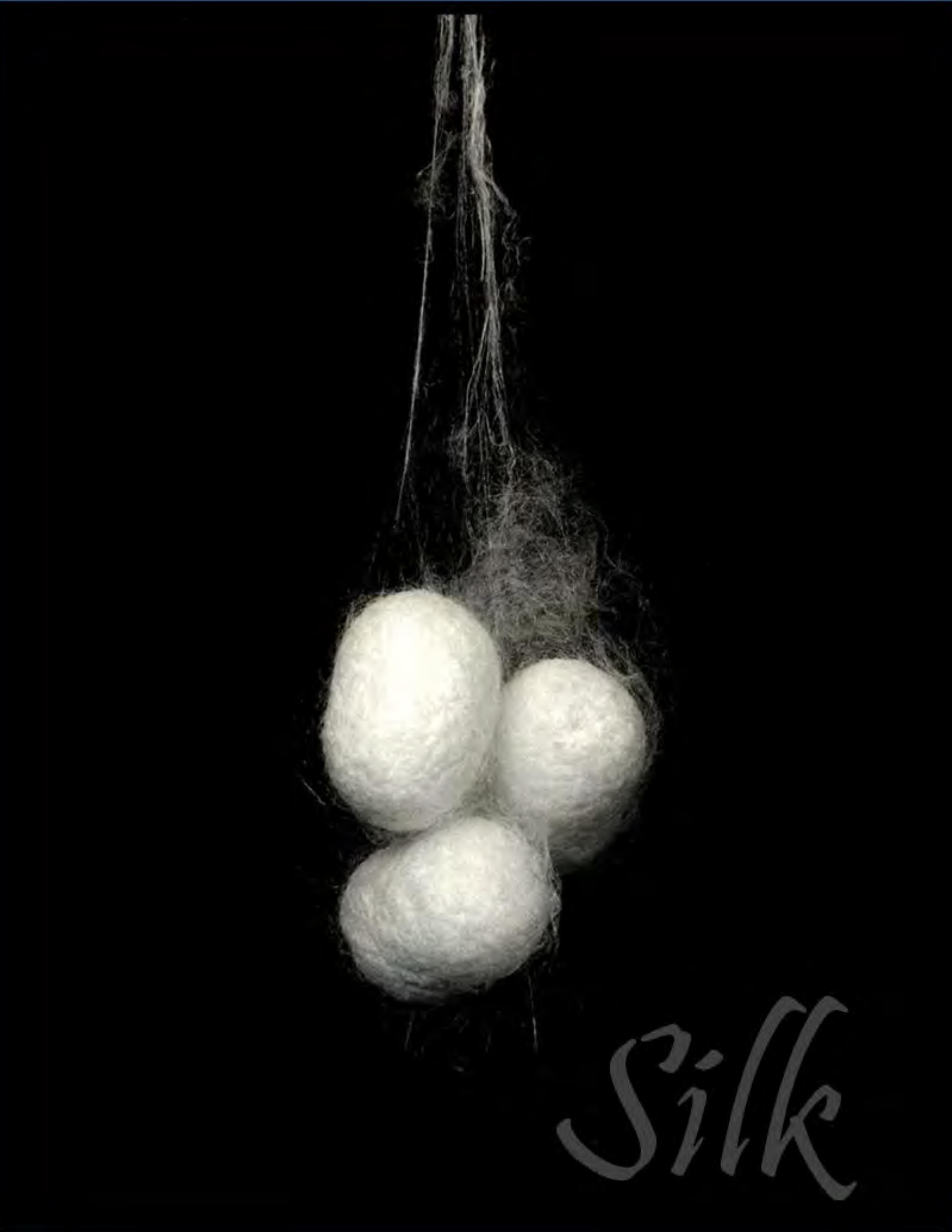
Tetradic (Double Complementary) Color Scheme

The tetradic (double complementary) scheme is the most varied because it uses two complementary color pairs (ex. yellow/blue & red/green). This scheme is hard to harmonize; if all four hues are used in equal amounts, the scheme may look unbalanced, so you should choose a color to be dominant or subdue the colors

Polychromatic Color Scheme

(all of the above)

The Polychromatic Color scheme is made up of many different colors (i.e. scrap quilts). Paradoxically, it is one of the easiest color schemes to balance. There are no rules with this scheme. The more colors, the more balanced and harmonious the effect.


Silk

The Story of Silk: Worms in Tea & Mulberry Trees

Have students look and touch silk top, silk scarves, and/or other available silk materials. Have students formulate guesses about the origins of silk. Have them write their guesses on the board or on sheets of paper and see which student's prediction is the most accurate. Why might it be important for us to know where all of our stuff comes from?

Did you know? Some of the world's most expensive clothing comes from a worm! Luxury, beauty, refinement, sensuality, elegance - silk is synonymous with all of these. No fiber - natural or man-made - rivals its versatility. Silk is light but strong, smooth and soft, supremely adaptable. It can be made wonderfully warm or deliciously cool, and dyed with infinite subtlety or boldness of color. When worn or draped, its fluidity is spellbinding. And it's been popular for over 7,000 years.

Sericulture or silk production has a long and colorful history unknown to most people. For centuries the West knew very little about silk and the people who made it. Pliny, the Roman historian, wrote in his Natural History in 70 BC "Silk was obtained by removing the down from the leaves with the help of water…" Which was completely inaccurate! For more than two thousand years the Chinese kept the secret of silk altogether to themselves. It was the most zealously guarded secret in history.

Falling into the truth-is-stranger-than-fiction category, the story of silk-its path from pupa to necktie-is inherently pretty interesting. But toss in a 5000-year-old Chinese legend about the discovery of silk, and the story becomes even more intriguing. There are many legends about the discovery of silk; some of them are both romantic and mysterious involving magic horses and lost love, and others merely commonplace with stories some ancient Chinese women finding this wonderful silk by chance when they were looking for ingredients for their dinner and picking up "fruits" from the trees.

Myths, Folktales and Legends – often these terms are used interchangeably, but each has a specific definition.

A myth is a sacred story. It may explain the origin of life or express a culture's moral values.

*** Please note that the term myth is commonly used to indicate something is false. That is not the definition that we will be using for this lesson plan. Teachers, please be sure to explain to your students that by referring to a religious story as a myth, you are not saying that story is false or trying to be disrespectful to that religion in any way.

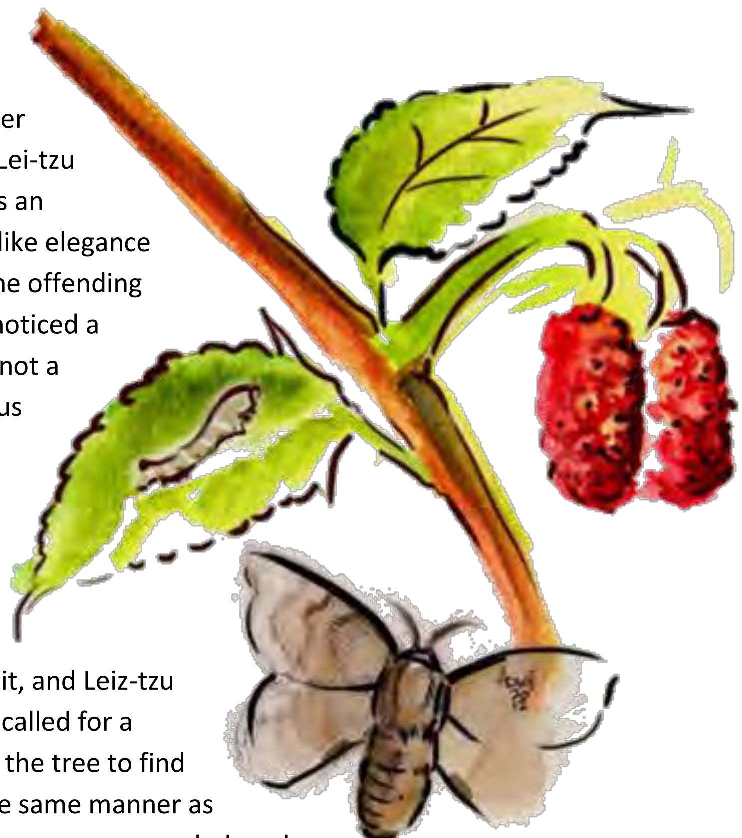
A folktale is a story that is pure fiction and may include elements of fantasy.

A legend is a story about the past that is believed to be true.

An oft repeated legend told about the origin of silk, is the following…(Illustrations by Adriana Hernandez)

Long, long ago (2700 B.C.E., if you must be exact about these things) there lived a wise and kind Chinese empress named Lei-tzu. Being an empress, she was a relative lady of leisure and much enjoyed spending her time wandering about the palace gardens. It was her habit to take her afternoon tea under the shade of one of the many mulberry trees in the garden. One day whilst doing this, she made a most amazing discovery.

Now mulberry trees were much desired in China, both for their pleasing appearance and their medicinal value. Lei-tzu, of course, knew this. But what she didn't know (at least not then) was that mulberry leaves are also the most favorite food of *Bombix mori*, a creamy white moth that's better known today as the silkworm. Now if you know anything about moths of any sort, you know that *Bombix mori* begins life as a rather ugly worm. In this form, it feasts to the point of bursting and then spins itself into a tight little cocoon that stays settled in the tree until the moth is ready to emerge. But sometimes a too-strong breeze or rustling of branches can push a cocoon off its comfortable perch.



One afternoon as Lei-tzu sat in the shade and sipped her tea, a cocoon dropped from the leaves and landed in her cup with a tiny splash. Though startled, Lei-tzu quickly regained her composure (she was an empress after all) and with as much ladylike elegance as she could muster, attempted to fish the offending matter from her cup. As she did so, she noticed a most remarkable thing. The cocoon was not a cocoon any longer, but one long, luxurious filament of silky fiber.

Now Lei-tzu was a thoughtful sort of woman, and so rather than dump out her tea in disgust, she took a closer look at the thread that now filled it. The fiber was soft with a lovely sheen to it, and Leiz-tzu thought it quite beautiful. Intrigued, she called for a servant boy and sent him scampering up the tree to find more cocoons. These she unwound in the same manner as the first, soaking them in her tea until the cocoon unraveled, and then carefully retrieving the beautiful lengths of fiber.

When several cocoons had been unwound, Lei-tzu began twisting the fibers together to see what could be made of them. She found that the twisting created a fine, soft, and surprisingly strong thread. "A fabric woven from this would make a fine robe for my husband," she thought. And so she quickly set out to find him.

Illustration by Adriana Hernandez

Lei-tzu's husband was the great emperor Huang-di, a most clever and powerful man—some say a god—who not only founded both the nation of China and Taoism (or so it is said), but also invented such marvels as the bow and arrow, the chariot, and an amazing mechanical wagon that, through a series of gears, would always point out the way south no matter which way the wheels turned.

Haung-di was equally enthralled with Le-tzu's discovery (being a shrewd soul, he quickly saw the value in producing such a fine fiber). "Wife," he said. "You have found a wonderful thing. We must put it to good use." So they taught the people of China to care for the silkworms, setting them on beds of clean straw and feeding them mulberry leaves all through the day and night. And when the cocoons were ready, Lei-tzu showed the peasants how to carefully reel the silk and weave the threads into fine and costly fabrics. For two thousand years, none but those taught by Lei-tzu knew the secrets of making silk. For many years after, Lei-tzu was known as Si Ling-chi or Lady of the Silkworm. How silk came to the rest of the world is a story for another time.


SILKWORM LIFE CYCLE
The female moth lays many tiny eggs.
EGG
A tiny black caterpillar hatches out of its egg.
The caterpillar eats mulberry leaves and grows bigger and bigger. It goes through 4 molts.
LARVA
The caterpillar spins a cocoon of silk threads around itself.
PUPA
Inside the cocoon, the caterpillar changes into a pupa.
People unwind the silk thread from the cocoons to weave into silk cloth.
The pupa changes into a moth. The moth comes out of the cocoon.
ADULT
The adult moths mate with each other.

That's a Lot of Worms!

There are many indigenous varieties of wild silk moths found in a number of different countries. The key to understanding the great mystery and magic of silk, and China's domination of its production and promotion, lies with one species: the blind, flightless moth, Bombyx mori. It lays 500 or more eggs in four to six days and dies soon after. The eggs are like pinpoints – one hundred of them weigh only one gram. From one ounce of eggs come about 30,000 worms which eat a ton of mulberry leaves and produce twelve pounds of raw silk. The original wild ancestor of this cultivated species is believed to be Bombyx mandarina Moore, a silk moth living on the white mulberry tree and unique to China. The silkworm of this particular moth produces a thread whose filament is smoother, finer and rounder than that of other silk moths. Over thousands of years, during which the Chinese practiced sericulture utilizing all the different types of silk moths known to them, Bombyx mori evolved into the specialized silk producer it is today; a moth which has lost its power to fly, only capable of mating and producing eggs for the next generation of silk producers. Adult *Bombyx mori silkmoths* cannot fly because their bodies are too big compared to their wings, and adult males cannot eat because they have underdeveloped mouth parts. Similar to cows who have been bred for maximum meat or milk production, silkworms have been bred to maximize silk production.

Go through the life cycle in detail, use the photos, and large poster of silk worms. Note: The book *Silkworms*, by Sylvia Johnson, is excellent for children and adults alike. It has great photos.

The Secret of Sericulture

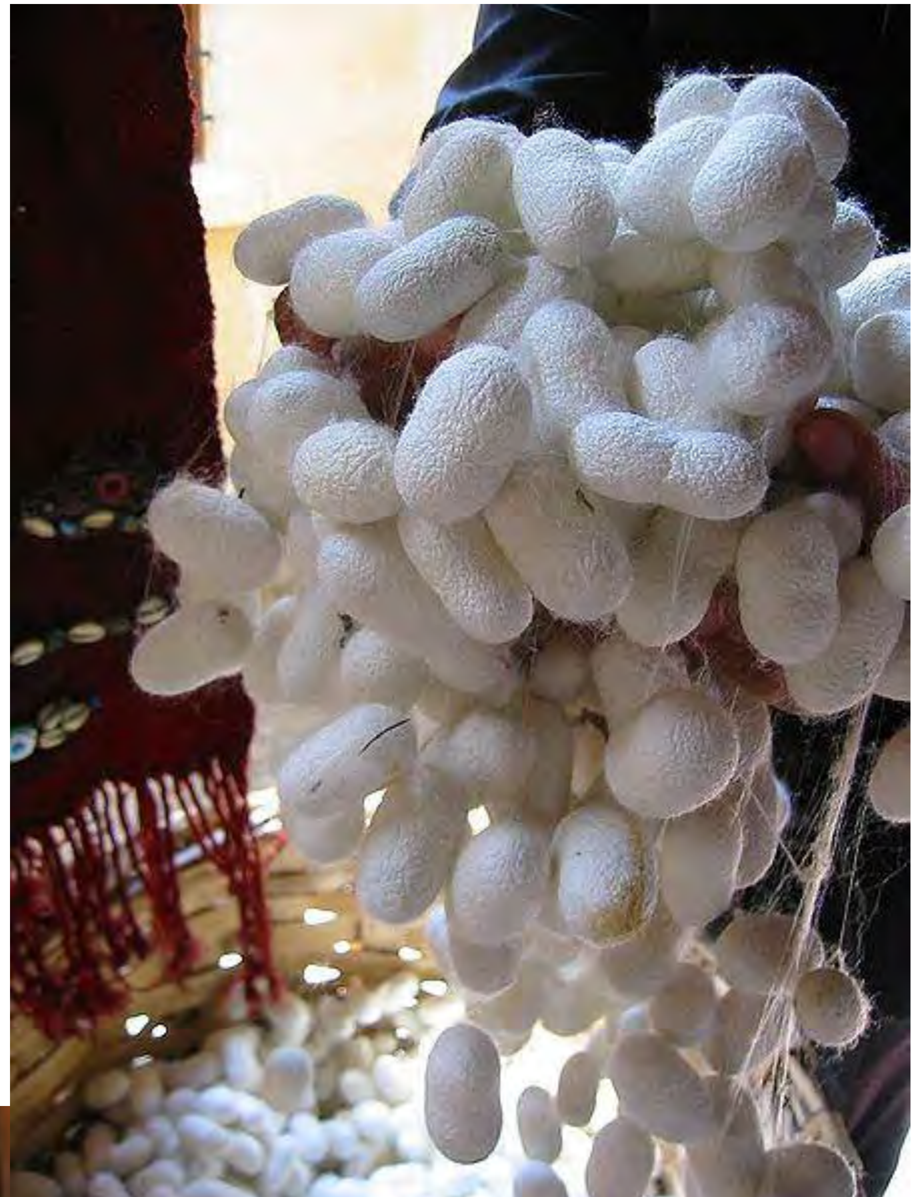
Producing silk is a lengthy process and demands constant close attention. To produce high quality silk, there are two conditions which need to be fulfilled – preventing the moth from hatching out and perfecting the diet on which the silkworms should feed. Chinese developed secret ways for both. Silk has a lustrous, almost shimmery finish. This is because the fiber is triangular in shape like a prism and refracts light at different angles; this gives silk its characteristic and prized sheen.

Burton Holmes from Ewing Galloway

THESE, THE COCOONS

The eggs must be kept at 65 degrees F, increasing gradually to 77 degrees at which point they hatch. After the eggs hatch, the baby worms feed day and night every half hour on fresh, hand-picked and chopped mulberry leaves until they are very fat. Also a fixed temperature has to be maintained throughout. Thousands of feeding worms are kept on trays that are stacked one on top of another. A roomful of munching worms sounds like heavy rain falling on the roof. The newly hatched silkworm multiplies its weight 10,000 times within a month, changing color and shedding its whitish-gray skin several times. It takes an average of 25-28 days for a silkworm, which is no bigger than an ant, to grow old enough to spin cocoon. The silkworms feed until they have stored up enough energy to enter the cocoon stage.

While they are growing they have to be protected from loud noises, drafts, strong smells such as those of fish and meat and even the odor of sweat. **Why do you think that might be?** Silkworms are incredibly delicate**.** Any loud noises, temperature changes, or even strong smells will cause silkworms to stop eating mulberry leaves. If this happens, they don't spin as much silk because they're not as big.



Then the women farmers will pick them up one by one to piles of straws, then the silkworm will attach itself to the straw, with its legs to the outside and begin to spin. When it is time to build their cocoons, the worms produce a jelly-like substance in their silk glands by their mouths, which hardens when it comes into contact with air. Silkworms spend three or four days spinning a cocoon around themselves until they look like puffy, white balls. Every silkworm will spin 1,000 yards of silk fiber in just three days.

Now, because humans have been raising and farming silkworms for so many thousands of years, the moth (called Bombyx mori) is 100% dependent on humans.

Though the silkworm now can't survive without human help, many humans wouldn't survive without the moths either -- many, many people around the world depend on the silk moth *for their livelihood, from peasant farmers who grow the mulberry leaves the silkworms eat and poor rural women who rear the moths and produce the precious cocoons, to the fashion boutiques in the world capitals that sell the luxury silk garments and fabrics.*

A hundred years ago the silk moth brought hundreds of thousands of peasant women in south China a new freedom they'd never had before when a world silk boom swelled demand, bringing prosperity to the women who raised the worms and spun the silk in their homes, and job opportunities for women workers in new local silk factories. A woman silk worker could earn enough to support a family of five.

If it's allowed to live, a silkworm moth is born blind and without the ability to even fly. It can't even eat! The Bombyx mori only lives long long enough to lay about 500 eggs, and then it dies.

The large majority of silkworms never live long enough to become a Bombyx mori moth, however. And this is where the tale gets a bit sad for the silkworm.

After the silkworm has spun its cocoon it will stay in there for 16 days as it transforms into a Bombyx mori moth. Once the transformation is complete, it will begin to excrete a fluid that dissolves a hole in the silk so it can emerge. Well, the silk farmers don't want their silk damaged by this fluid, so once the cocoon is completely formed after 8-9 days they toss all the sacks into boiling water to kill the silkworms. However, enough silkworms are allowed to mature to continue the species.

The next step is unwinding the cocoons; it is done by reeling girls. Remember, this must be done at the right time, otherwise, the pupas are bound to turn into moths, and moths will make a hole in the cocoons, which will be useless for reeling. Cocoons are dipped into hot water or boiled so that the thread can unravel as a single strand; boiling also strengthens the fiber and loosens the tightly woven filaments. To unwind the cocoons, after they are put in a basin filled with hot water, the workers find the loose end of the cocoon, and these filaments are unwound onto a spool. At last, two workers measure them into a certain length, twist them, they are called raw silk, then they are dyed and woven into cloth.

How Many Silkworms Does It Take?

Have students examine cocoons. Can they see threads? What do they feel like? Can they unravel one?

Any other insect that attacked such a useful, multi-purpose plant as a mulberry like that would be a farmer's deadly enemy, the target of poison sprays and biological controls like killer wasps or bacterial diseases. But we treasure the silk moth, and it rewards us well -- today's silk industry is worth about $2 billion a year worldwide.

Annual world production is estimated at about 100,000 tons -- more than 600 billion cocoons. A single cocoon contains anything between 0.5 and 1.5 kilometres of thread. Each cocoon is made up of a filament between 600 and 1000 meters (nearly ten football fields long!) Between five and eight of these super-fine filaments are twisted together to make one thread.

An average of 2500-3000 cocoons are needed to make one yard (equals 0.9144 meter) of silk fabric. **Have students figure out ratios and amounts, making estimates of how many cocoons might be needed to make different garments, ex:**

- 111 cocoons are needed for a man's tie It takes about 5,000 silk worms to create one silk dress (How many yards of fabric would that be?)
- Over 630 cocoons are needed for a woman's blouse. It takes about 5,000 silk worms to create one silk dress (How many yards of fabric would that be?)
- It takes about 5,000 silk worms to create one silk dress (How many yards of fabric would that be?)
- To make a sari 44 inches wide and 5 yards long you need: 8,000 silkworm eggs, which will yield 1,200 cocoons (because of high mortality rate). These silkworms will eat the leaves of between 12 and 14 trees, each approximately 12 feet tall. It will take over 112 hours (14 eight hour days) to prepare the 14 ounces of yarn necessary to weave one lightweight sari.

Strong Threads, Strong Teeth, Strong Fish

Silk thread can also be produced by killing silkworms while they are in their caterpillar stage, just before they spin their cocoons, and extracting the two silk glands. Each sac holds a tightly bundled mass that when unwound, stretched, and properly treated will make a single strand about twelve to fifteen inches in length that is allowed to harden, these silk threads are known as silkworm gut, a hard, semi-transparent and very strong substance. IN THE EARLY 1700s, after anglers had been using horsehair lines for more than a thousand years, they finally discovered that nature had a better idea. It was a natural leader material that, by comparison with horsehair, was so remarkable for translucence, flexibility, and strength that it would eventually dominate the sport.

It was silkworm gut, which is used mainly to make fly fishing lures for trout, bass and salmon. The Chinese, who had apparently been fishing with gut for centuries before anyone else learned of it, were fiercely secretive about all aspects of silk manufacturing.

But by the early 1800s, the silkworm gut market flourished, and a minimum set of standards for quality emerged. Though several countries grew silkworms, Spanish gut dominated the top-end market.

There was, by the way, a dark underside to this whole enterprise. Until at least the early 1800s, silkworm gut was the product of a strange little cottage industry (items manufactured in small cottages or homes by crafters) that most fishermen were just as happy not to know about.

H. P. Wells, in *Fly-Rods and Fly-Tackle* (1885), described how each gut strand was handled and processed in a typical small Spanish shop:

Their first step is to free the gut from such portions of the ruptured envelope [in the caterpillar] as may adhere to it. Formerly this was done by drawing the gut between the teeth, and thus stripping off this refuse, [now chemical processes are said now largely to have taken the place of this.] The eyewitness, to whom I am indebted for this information, describes the old method as a most disgusting spectacle. The rows of women and girls drawing the entrails (guts) of this caterpillar through their teeth, their mouths smeared with blood from the cuts inflicted by the thin gut, mingled with the offal scraped from it by their teeth — spitting and drawing, and spitting again — must indeed be far from a pleasant sight.

Why is silkworm gut so good for flyfishing? Strength. For streams where there is always more or less motion to the water the leader is subjected to a greater strain in stream fishing it must be strong.

Absorbency: Even when soft, gut continues to soak up a little water, thus helping lock its knots in place.

*Finally the silk threads are woven into cloth or used for embroidery work. Clothes made from silk are not only beautiful and lightweight, they are also warm in cool weather and cool in hot weather.

Literary sources such as The Book of History, and The Book of Rites give further information about sericulture. Reeling silk and spinning were always considered household duties for women, while weaving and embroidery were carried out in workshops as well as the home. In every silk-producing province the daughters, mothers and grandmothers of every family devoted a large part of the day for six months in a year to the feeding, tending and supervision of silkworms and to the unraveling, spinning, weaving, dyeing and embroidering of silk. By the fifth century BC, at least six Chinese provinces were producing silk. Each spring, the empress herself inaugurated the silk-raising season, for silk production was the work of women all over China. The technique and process of sericulture were guarded secrets and closely controlled by Chinese authorities. Anyone who revealed the secrets or smuggled the silkworm eggs or cocoons outside of China would be punished by death.

Did You Know?

Silk can also be made without killing the caterpillars. Eri silk or "peace silk" is made from the cocoons of *Samia ricini*, a type of silkworm who spins a cocoon with a tiny opening in the end. After metamorphosizing into moths, they crawl out of the opening. This type of silk cannot be reeled in the same way that *Bombyx mori* silk is reeled, and instead is carded and spun like wool. Eri silk represents a very small portion of the silk market.

Another type of silk is Ahimsa silk, which is made from the cocoons of *Bombyx mori* moths after the moths chew their way out of their cocoons. Because of the chewed-through strands, less of the silk is usable for textile production and Ahimsa silk costs more than conventional silk. "Ahimsa" is the Hindu word for "non-violence." Ahimsa silk, though popular with Jains, also represents a very small portion of the silk market.

Silk Development in China

When silk was first discovered, it was reserved exclusively for the use of the ruler. **Today what might people at the top only have access to? Designer clothes? Private**

airplanes? First class flights? What's off limits now to the general public? Special travel destinations? It was permitted only to the emperor, his close relations and the very highest of his dignitaries. Within the palace, the emperor is believed to have worn a robe of white silk; outside, he, his principal wife, and the heir to the throne wore yellow, the color of the earth.

Gradually the various classes of society began wearing tunics of silk, and silk came into more general use. As well as being used for clothing and decoration, silk was quite quickly put to industrial use by the Chinese. This was something which happened in the West only in modern times. Silk, indeed, rapidly became one of the principal elements of the Chinese economy. Silk was used for musical instruments, fishing-lines, bowstrings, bonds of all kinds, and even rag paper, the world's first luxury paper. Eventually even the common people were able to wear garments of silk.

During the Han Dynasty, silk ceased to be a mere industrial material and became an absolute value in itself. Farmers paid their taxes in grain and silk. Silk began to be used for paying civil servants and rewarding subjects for outstanding services. Values were calculated in lengths of silk as they had been calculated in pounds of gold. Before long it was to become a currency used in trade with foreign countries. This use of silk continued during the Tang as well. It is possible that this added importance was the result of a major increase in production.

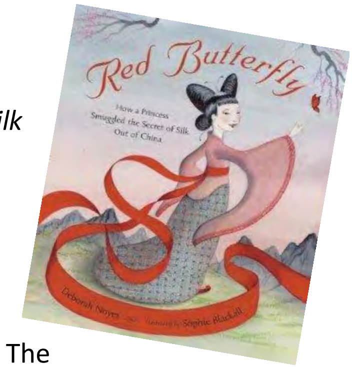
A Secret Out to the World

In spite of their secrecy, however, the Chinese were destined to lose their monopoly on silk production. Despite their best efforts, the Chinese were unable to prevent the Europeans from smuggling silkworms and the secrets of their culture to their own countries. Sericulture reached Korea around 200 BC, when waves of Chinese immigrants arrived there. Silk reached the West through a number of different channels. Shortly after AD 300, sericulture traveled westward and the cultivation of the silkworm was established in India.

It is also said that in AD 440, a prince of Khotan (today's Hetian)--a kingdom on the rim of Taklamakan desert -- courted and won a Chinese princess. The princess smuggled out silkworm eggs by hiding them in her voluminous hairpiece. This was scant solace to the silk-hungry people of the West, for Khotan kept the secret too. Why share it with the westerners and kill a good market?

The Princess and the Stolen Cocoons or How the Secret of Silk Was Revealed

As retold by Daryl Brower/ Illustrations by Adriana Hernandez



Read another version in *Red Butterfly: How a Princess Smuggled the Secret of Silk Out of China* by Deborah Noye

Long, long ago (let's say 350 AD) there lived a Chinese princess who had reached an age at which it was expected she would be married. Now as was the custom of those times and that place, her parents had made a fine match for her when she was not more than a girl, promising her to a Prince of Khotan. The princess was much pleased by this for she was told by all that it was good match, the prince was a handsome and charming man, Khotan was a fine city, and truth be told, she was rather looking forward to the adventure of living in a new land.

There was one thing, however, that troubled her. She must leave behind her home of splendors: sour plums and pink peach petals and — most precious and secret of all — the small silkworm. For though the prince was rich and Khotan was a worldly place filled with all the luxuries to which the princess was accustomed, there was one thing that was not to be found there at any price: silk. And silk was something a princess could not live without. She is sad that she has to leave all that is dear and familiar to her, and decides that she will carry a living reminder of her native land, in the form of tiny silkworms. The young princess knows that it is an act strictly forbidden for China greatly prizes the secret of weaving silk and wants to keep it within China.

The making of silk you see, was a secret known only to the people of China. Only the daughters, mothers and grandmothers of the land knew how to properly feed and tend to the silkworms so that they would produce the finest of fibers, and only they knew how to spin, weave, and dye it into a fabric. The women had learned all this from the Empress Lzi-tu, (you can read her story here) and the secret had been kept close for some 3,000 years. The punishment for anyone who revealed the secrets of silk-making—or worse still—smuggle silkworm cocoons out of China, was death.

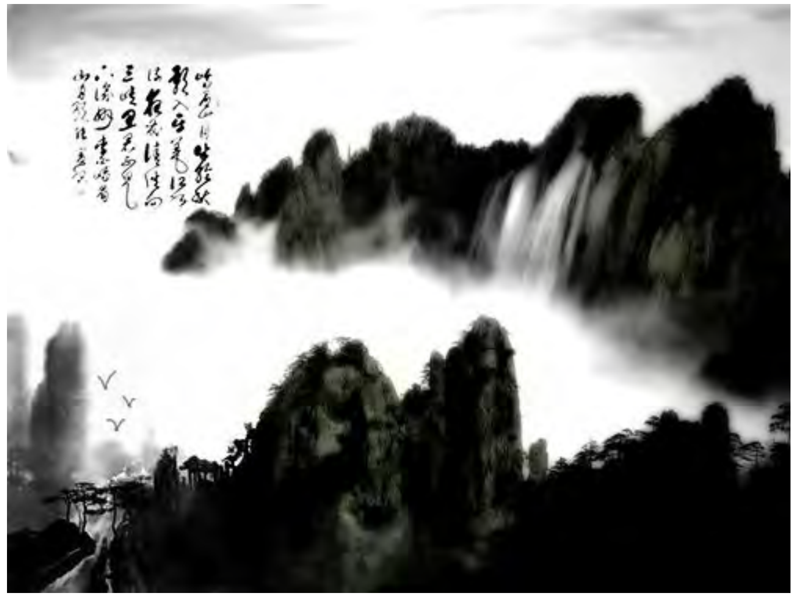
The princess knew all this, but as her wedding day drew closer and closer, she realized she could not do without this wondrous fiber and decided that she would bring the secrets of silk-making with her to her new home. One night when all were asleep, she slipped into the palace courtyard and carefully gathered a bundle of seedpods and leaves (with the precious silkworm eggs firmly attached) from the mulberry trees that grew there. Returning to her room, she hid these treasures in the elaborate headdress that she would wear on the procession to her new home.

When morning came she dressed in all her finery and rode out to meet her new husband, all the while hiding the wealth of an empire in the voluminous folds of her wedding headdress, and no one was the wiser. It wasn't until many months later that she shared the secret with her husband, showing him the now fully-formed cocoons that she had been so carefully tending. Her husband was delighted with her cleverness and, just as Lei-tzu and had done centuries before, they set up silk making in Khotan, turning a tidy profit as they did so.

Scroll Quickly!

In China, there are more than 3,000 dialects of Chinese being spoken; however, Chinese writing symbols are all the same across the regions. So people from different provinces in China speak different dialects, but use the same written language. This will help us in our time of need.

We need to create a warning letter, or a detective letter, to the emperor who is trying to track the princess or give warning to the princess that the guards are close behind her and a map to her journey ahead. Students must create a landscape drawing showing the emperor the princesses' secret destination or stops along her way to go with their message. Or, it can be a secret message to the princess, showing her the safe ways to travel and escape the eyes and arms of the emperor.



Chinese writing characters go back more than 3,000 years. To read Chinese you have to learn symbols called characters. These sometimes look like little pictures, which is just what they were originally. The symbols began as pictures. Pictures were drawn to resemble the items they represented. Some characters or parts of characters are based on pictures, other parts represent sounds. Each character represents one syllable (part of a word), and words are often made up of two or more characters.

In ancient China, students had to memorize many pictures or characters each week and used brushes and ink to paint the "words". We only have to learn the 26 letters in the alphabet to be able to read and write. Imagine trying to memorize hundreds even thousands of pictures in order to be able to read and write!

There is no Chinese alphabet in the sense we understand it in the West. Chinese characters are not letters (with some exceptions), Chinese characters represent an idea, a concept or an object. While in the west each of the letters of our alphabet represents a sound that generally has no particular meaning. In modern Chinese there is a set of more than 400 syllables, made of two elements: an initial, the sheng and a final the yun. The first part, the sheng is the consonant that begins a syllable. The sheng is followed by a yun that is usually a vowel.

Chinese can be written using either traditional or simplified characters. Across mainland China simplified characters are used. On the other hand, people in Hong Kong and Taiwan’s well as many Chinese people living in other countries use the more complicated traditional Chinese characters.

Silk found its way so thoroughly into the Chinese language that 230 of the 5,000 most common characters of the mandarin "alphabet" have silk as their "key" or starting point. Chinese character writing is done in columns, from top to bottom and from right to left. So you start writing in the upper right-hand corner of the page.

Materials:

- Newspaper to cover desks
- Butcher paper, one large sheet per student
- Resources such as the book First 1,000 Words in Chinese for examples of the Chinese alphabet
- Computer with Internet access (optional)
- Examples of Chinese symbols and characters
- Black paint (tempera or watercolor paint)
- Calligraphy brushes, one per student (or substitute watercolor or tempera paintbrushes)
- White construction paper, 2 sheets per student
- Colored construction paper

Tell students they will create their own works of art using Chinese calligraphy. Have them cover their desks with newspaper and distribute the paintbrushes. Discuss the five principles of Chinese calligraphy with students:

- Posture: It is important to sit up straight.
- Good knowledge of the tools: Demonstrate with the same the brushes students will use.
- Control: You must know how to control the brush.
- Rhythm: The characters should flow smoothly down the page.
- Balance: Make sure all the lines are the right thickness and length.

In China and Japan, calligraphy and painting were traditionally considered one and the same. The same brush strokes that were used in writing were also used in
traditional Chinese and Japanese painting.
Give students the examples of Chinese characters, words, and symbols, and tell them to choose several to reproduce to formulate their message on white construction paper to practice, they'll put final versions on their finished paintings later
Japanese Sumi-e landscape painters **do not draw their pictures before painting them**. Instead they use a complex vocabulary of brush strokes. By combining these brush strokes they can create just about any picture **without drawing it first**. All of these brush strokes can be created with a soft, round bamboo brush.
Traditional Chinese landscape painting (Shan shui; literally Mountain-water) has very little, if any color. Shan shui painters relied instead on progressively lighter washes of ink to give their landscapes a sense of dream-like realism.

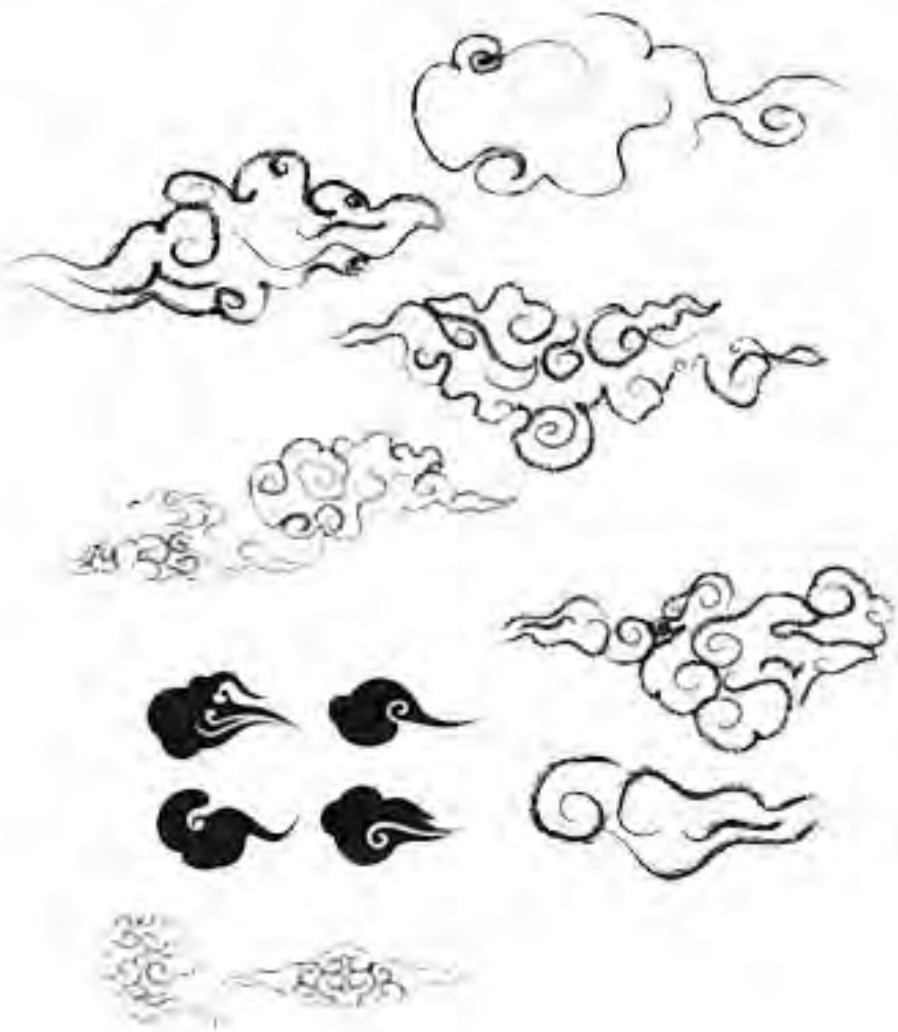
Note: Shan shui paintings involve a complicated and rigorous set of almost mystical requirements for balance, composition, and form. All shan shui paintings should have 3 basic components:

- Paths - Pathways should never be straight. They should meander like a stream. This helps deepen the landscape by adding layers. The path can be the river, or a path along it, or the tracing of the sun through the sky over the shoulder of the mountain.. The concept is to never create inorganic patterns, but instead to mimic the patterns that nature creates.
- The Threshold - The path should lead to a threshold. The threshold is there to embrace you and provide a special welcome. The threshold can be the mountain, or its shadow upon the ground, or its cut into the sky. The concept is always that a mountain or its boundary must be defined clearly.
- The Heart - The heart is the focal point of the painting and all elements should lead to it. The heart defines the meaning of the painting. The concept should imply that each painting has a single focal point, and that all the natural lines of the painting direct inwards to this point.

Tip:

Atmospheric perspective: Objects in the distance appear progressively lighter and less distinct as they get farther away.
Students can create atmospheric perspective effects in their watercolor paintings by adding water to the paint, painting a layer of mountains and then adding more water to the paint before painting the next layer farther away. This will create the illusion that their mountains are fading in the distance.
Use black paint or waterproof ink diluted with water to create atmospheric effects.
Waterfalls: When painting a waterfall always start at the top of the falls and paint downwards, towards yourself. Start with a curved brushstroke and then continue straight down as if the water is falling to earth; obeying the laws of gravity. Lift your brush slightly as you paint downwards, so that your line becomes thinner the lower you go, until your brush lifts off the page entirely.

Some traditional Chinese cloud designs made entirely of curved lines



Monks: Thieves in Flight

Then around AD 550, two Nestorian monks appeared at the Byzantine Emperor Justinian's court. an These monks had been living in China and knew the method of raising silkworms. The Emperor promised a high reward if the monks would bring the secret to him. With silkworm eggs hid in their hollow bamboo staves and mulberry saplings hidden under their tunics the monks returned. Under their supervision the eggs hatched into worms, and the worms spun cocoons. Byzantium was in the silk business at last. The Byzantine church and state created imperial workshops, monopolizing production and keeping the secret to themselves. This allowed a silk industry to be established in the Middle East, undercutting the market for ordinary-grade Chinese silk. However high-quality silk textiles, woven in China especially for the Middle Eastern market, continued to bring high prices in the West, and trade along the Silk Road therefore continued as before. By the sixth century the Persians, too, had mastered the art of silk weaving, developing their own rich patterns and techniques. It was only in the 13th century—the time of the Second Crusades—that Italy began silk production with the introduction of 2000 skilled silk weavers from Constantinople. Eventually silk production became widespread in Europe.

Silk Today

World silk production has approximately doubled during the last 30 years in spite of man-made fibers replacing silk for some uses. China and Japan during this period have been the two main producers, together manufacturing more than 50% of the world production each year. During the late 1970's China, the country that first developed sericulture thousands years ago dramatically increased its silk production and has again become the world's leading producer of silk.

Currently, Japan is the largest exporter of silk cloth, closely followed by China. However, silk from Thailand, Cambodia and India each have their own special characteristics and are highly prized. The process from silkworm to finished fabric remains remarkably similar to ancient methods.

Silk fabric is traded and sold every day all over the world. Whether it's silk sheets or a silk necktie, silk is still a sought after item that people are willing to pay a lot of money for it. "In the year 2006, Ministry of Commerce estimates that annual silk industrial output value was expected to reach US $31.25 billion in 2010.

Thousands of years have passed since China first discovered silkworms. Nowadays, silk, in some sense, is still a luxury. Some countries are trying some new ways to make silk without silkworms. Hopefully, they can be successful. But whatever the result, nobody should forget that silk was, still is, and will always be a priceless treasure.

Silk Printing

Note: the book Printing by Hand: A Modern Guide to Printing with Handmade Stamps, Stencils, and Silkscreens will be an invaluable resource and tool throughout this section.

Silk screen printing may be the oldest and most practical printing technique dating back to ancient times. There are hypotheses that silk printing's origins started in China at least 12 centuries before Christ when silk began to be produced there. Silk printing may have originated not far from the Mediterranean Sea between Mesopotamia and Phoenicia according to available historical facts. There are a number of archeological finds and historical studies that indicate that the Phoenicians found a way to reproduce patterns on fabrics using techniques uncommon to those used today. However, they can be credited with pioneering a system of image duplication by using stamps to reproduce simple patterns.

The method was later improved in Japan to a printmaking technique that created sharp-edged images using a stencil and a porous fabric. Katagami was the ancient Japanese art of dyeing fabric with stencils. The grandfather of silkscreen printing, katagami was a technique that began in the 17th century and was an improvement on the ancient Chinese art of stencil printing. The Japanese used simple stencils which were glued onto a screen made of human hair that was stretched over a wooden frame. This printing technique was then further improved throughout the Middle Ages and became widespread in Europe.

Foam Stamps: Basics

A print from a foam stamp often has a solid and saturated appearance due to the buoyant and porous quality of the foam, which makes it perfect for printing on textured surfaces. The look of a foam stamp print, like all printing methods, depends on the application of ink and the pressure used as the stamp is pressed to the printing surface. Lightly pressing will give a mottled or spotty print and pressing firmly will give an even and saturated print.

Making a Foam Stamp:

Having students make foam stamps isn't complicated. They will draw a design directly onto a sheet of foam or transfer a design from a piece of paper with a soft lead pencil and rubbing stick.

Then have students cut the shapes in the design from the foam sheet with small sharp scissors.

Next, have them attach the cut out foam pieces to a backing (this is made easier if you use sticky-back foam) ONE at a time.

The backings used for foam stamps are usually clear acrylic/plastic mounts (without a handle, as you will need it to lie flat on and event surface while you assemble the design.) A clear mount allows you to put a print-out of their design underneath their mount and put the foam pieces over the coordinating spot in their design. It also allows them to better see where they are printing.

When making foam stamps, limit students to shapes that they can cut cleanly with a pair of scissors. Have them get a sense of how detailed their design can be by practicing cutting shapes from paper, then try cutting the shapes from foam. If they can finalize a design by cutting out shapes from paper, they can then trace around the paper with pencil onto the foam.

Remember that a foam stamp is a MIRROR image of its print, so letters and numbers (and anything else that needs to go a certain direction) will have to be reversed in the artwork. See below for guidelines.

Printing with Foam Stamps:

Foam stamps are most commonly used with an inkpad or acrylic ink. In general, an inkpad will give a soft thin print, and acrylic ink will give a thicker, more saturated print. Acrylic ink can be applied to a foam stamp with a foam brayer or paintbrush.

If ink gets on the backing have students wipe it off before printing or it may make unwanted marks on their printing surface. Foam stamps work very well on all types of paper and many fabrics, but different inks on different surfaces will give varied results. Always make sure that the ink students are using is right for the surface material they are using.

Guidelines:

- Stamps: If students want the print of your design to face the same direction as it does on the photo copy, they will need to transfer it to their tool material with a rubbing stick/bone folder after tracing it (print side **down**) with a soft lead pencil.

  If they want the print of their design to face the opposite direction, they will need to trace over the design on the on the right side or printed side of the design with a soft lead pencil and transfer it with the bone folder or rubbing stick.

- Stencils and silk screens: Here the opposite rules apply. If they want the print of their design to face the same direction as it does on their photocopy, they need to trace over the on the right side of the photocopy and transfer it with a rubbing stick/bone folder. If they want their design to face the opposite direction, transfer it to tool material by tracing the back side (design down) with a soft pencil, and transfer it to the tool with the rubbing stick.

Foam Stamps: Furoshiki Project

When Japanese isolation ended in the mid-19th century, Japanese merchants began freely trading with other countries. The Japanese brought their unique silkscreened fabrics to world fairs and gained much admiration for their design and beauty, and the techniques used to create them were soon replicated in other areas.
This project was inspired by the Japanese tradition of using cloth to wrap gifts, called *furoshiki*. The word furoshiki means “bath spread,” a reference to the way Japanese bathers would bundle their clothes at the public baths. For this project students may use large foam stamps to print their fabric. The foam contours to the shape of the fabric when pressed and makes textured saturated prints.

Materials:

- Natural colored linen

- 6”x9” foam sheets with adhesive backing, note: younger students may need pre-cut adhesive shapes
- 7”x11” acrylic mount

Tools:

- Old towels
- Newsprint or kraft paper
- Soft lead pencils
- Bone folders/tracing sticks, ex. large popsicle craft sticks
- Scissors
- Plastic spoons
- Paper or plastic cups
- Paper plates or palettes
- 4” foam brayer/roller

Prepare work surface.

1. Students will need a work surface of approximately 3’x4’ each. Have them lay an old towel or other material on the surface for cushioning.

Transfer design:

1. Have students choose a photocopy of the artwork they want to use or create their own pattern on an 8 ½ x 11” piece of copy paper. Have them place the paper, design-side DOWN onto their work surface.

2. Have students trace around the design on the back of the photocopy with a soft-lead pencil. They should be able to see through the paper easily.

3. They will then set a foam sheet, foam-side up, on their work surface.

4. Next, have students take the paper (with the traced design) and set it, traced-side DOWN, onto the foam sheet and rub the back of the paper with the edge of the stick or bone folder in order to transfer their design to the foam. Once finished they will lift the paper and set it aside.

Making the Stamp:

Have students placed the traced paper, print-out side UP, on their work surface, and set the acrylic/clear mount over the design, roughly centering it. They will be able to see their design through the mount.

With scissors, students will carefully cut a shape in the design from the foam. Peel off the adhesive backing from the shape they just cut out and press the foam piece to the surface of the acrylic mount, over the same shape in the design (as seen on the paper under the acrylic mount). Continue cutting out shapes and pressing them to the mount one at a time until all the pieces are firmly attached to the mount.

Mix Ink:

Mix inks in paper or plastic cups using a plastic spoon. If students don’t mix the ink very well, streaks may appear in their prints.

- For green ink: 4 Tablespoons green ink, 1 teaspoon white ink, and a drop of black ink.
- For blue ink: 4 Tablespoons blue ink, 2 teaspoons white ink, and a drop of black ink.
- For brown ink: 4 Tablespoons brown ink and 1 teaspoon white ink.

Note: To keep colors pure, have students only print with one color at a time and wash the stamp thoroughly between printing sessions.

Test print:

1. Set the test-printing fabric on their work surface, with newsprint between the fabric and the towel.
2. Scoop a tablespoon of ink onto the paper plate. Roll the roller/brayer through the ink, coating it evenly. Roll a layer of ink onto the surface of the foam pieces, without applying pressure (this prevents ink from getting on the acrylic backing).
3. If ink does get on the backing, wipe it away.
4. Turn the stamp over and lower it onto the surface of the test fabric. Apply pressure to the stamp with both hands for several seconds, pressing into the stamp with their body weight.
5. Lift the stamp. If the print is too light, either more ink is needed, or more pressure is needed when pressing the stamp to the fabric. If excess ink is pooling around the edges of the design, they have applied too much ink—wipe the excess from the edges of the stamp, and roll on a lighter coat for the next print.
6. Continue making test prints, reapplying ink to the stamp and wiping excess ink from the edges between each one. When their prints come out clean and even students need to write down the amount of ink used as well as the time and pressure needed. *Note: If they print off the edge of the fabric, make sure they put newsprint over the towel to prevent ink from getting on the towel.*

Print:

1. Have students place a fresh piece of fabric on their work surfaces.
2. Roll a new coat of ink onto the stamp, and position it at one corner of the fabric.
3. Lower the stamp to the fabric. Press firmly, as they did earlier, then lift.
4. Continue making prints, reapplying ink to the stamp and wiping excess ink from the backing between each print. The design for this project is meant to appear in random places on the fabric.

Clean Up:

1. Place the stamp on the newsprint to remove excess ink and wipe away any ink that has collected on the sides of the foam pieces.
2. Wash the stamp and foam brayer/roller gently under water.
3. Add a droplet of soap to thoroughly clean the stamp, and rinse with water.
4. Allow the stamp to air-dry completely before using again.

Stencil Screen Printing

Carved rubber block stamps: basics

Though this technique creates a uniquely hand-cut print, like the other techniques it can be both soft and mottled, or solid and saturated, depending entirely on the amount of ink and pressure applied to the stamp. For example, when younger students print t-shirts or other fabric, they might want a bright saturated look. Older students might choose a softer subtler look.

Carving a rubber block stamp (or a potato):
Blocks made from rubber or rubber-like material, come in a variety of sizes. They are easy and fun to carve with a carving tool or a utility knife. Both glide almost effortlessly through the rubber, but a cutting tool is much easier to use for detailed shapes.

Students can draw a design directly onto a rubber block, or transfer one from a piece of paper using a soft-lead pencil and bone folder/popsicle stick using the same technique as in the last project.

For cutting away large areas in the background of the design with the cutting tool, have students use the U-shaped blade; for cutting details use the V shaped blade. The blade tips of the tool are not very sharp, and do not cut skin easily. Still it's a good idea to not test this, and it is important to teach students to always cut AWAY from their body when carving out a design. Teach them to rotate the block instead of their hand when changing directions.

Have students hold the tool like they would a remote control, and push it with scooping movements into the surface of the rubber block. Keep the top of the blade above the surface of the rubber material. If the entire tip dips below the surface, it will tear the rubber when you bring it back up. Cuts should never go more than halfway through the depth of a block, or the block becomes weak and tears. Rubber block stamps do not have to be mounted on backings, but it makes large stamps easier to hold, especially for making many prints.

Remind students that a stamp is a mirror image of its print, so letters, numbers, and anything that needs to be seen in a certain direction will have to be reversed in the artwork. The technique for reversing is mentioned in the prior project. The detail of the design is limited to the smallest cutting attachment on the cutting tool and how well the students can maneuver the tool. Some shapes and angles, such as those with tight corners, are difficult to carve. Have students take into account that it might be hard to carve out their design exactly as they drew it. Encourage them to embrace the imperfections, they add to the beauty.

Printing with Carved Rubber Block Stamps:

Rubber block stamps can be used to print on a variety of papers and fabrics and work well with block-printing ink, an acrylic ink that comes in both a fabric and non-fabric variety made for this technique. Ink can be applied using a foam brayer/roller or a paintbrush. An inkpad can also be used if a very thin light print is desired. If students accidentally get ink on the carved-away areas in their design, make sure they wipe it off before they print. Always make sure the ink being used is right for the surface material students are working with.

Potato Printing Variation

Sometimes, the most ordinary items can be used to create extraordinary results. For small stamps, potatoes (white potatoes, russets, sweet, or red potatoes) also make excellent easy-to-make stamps. Peel potato to create a smooth edge. Carve out shapes, ex:.

For a gator: Cut two large potatoes in half and use to make five potato stamps: a rectangle for the body, four green feet, tail shape, mouth, and a small triangle for spikes on the back. *Carve away everything else EXCEPT the shape...so when you ink it up, whatever is "tallest" is inked.* Place potato stamps on a paper towel to absorb excess moisture. Do this only the first time you use the stamp. Stick a fork in larger potatoes for stability when stamping.

For a bluebird: Create four potato stamps of simple shapes: a tail feather and three half-circles for the body, head, and wing. Place potato stamps on a paper towel to absorb excess moisture. Do this only the first time you use stamp. Apply paint to the flesh of the potato with a foam brush. Use a lighter color for the wing stamp to differentiate it from the body. Slide cardboard under material to block the paint from bleeding through to the towel. Press the potato stamp firmly onto the fabric. Stick a fork in larger potatoes for stability when stamping. Use a detailing brush to create details on the beak.

Carved rubber block stamps: Kid's Rubber Stamp T-Shirt Project

Materials:

- Off-white or white T-shirts
- T-shirt scraps, for test printing
- 6"x8" rubber carving blocks
- Potatoes
- 8 oz containers block-printing fabric ink

Tools:

- Newsprint or kraft paper
- Soft-lead pencil
- Bone folder/craft sticks
- Utility knives
- Self-healing cutting mats/work surface
- carving tools with multiple attachments
- 12"rulers
- 4" foam brayer/rollers
- Plastic spoons
- Paper or plastic cups
- Paper plates/palettes
- Iron

Prepare Work Surface

1. Students will need a work surface of approximately 2'x3', covered in newsprint or kraft paper.

Transfer Design

1. Have students choose a photocopy of the artwork they want to use or create their own pattern on an 8 ½ x 11" piece of copy paper. Have them place the paper, design-side DOWN onto their work surface.

2. Have students trace around the design on the back of the photocopy with a soft-lead pencil. They should be able to see through the paper easily.

3. Using a ruler, utility knife, and a self-healing cutting mat, trim the rubber block to 6"x6".

4. Place the paper, traced-side down, onto the rubber block. Rub the back of the paper with the edge of a bone folder or large craft stick in order to transfer the design onto the rubber block. Lift the paper, and discard.

Carve Stamp:

Fit the carving tool with a 1/8" V-shaped tip. Hold the cutting tool like a remote control, with the attachment positioned like a shovel. Carve out all of the areas **surrounding** the pencil lines in the design. Be sure not to let the top of the blade sink below the surface or it will tear the rubber when it reemerges. When changing cutting directions, always rotate the block instead of rotating their hand, so that they are cutting away from their body. Switch to the larger U-shaped tip to carve the empty areas out-side of the design.

When the entire design has been carved, move the block to a self-healing cutting mat and trim around the edges of the design with the blade tip of the carving tool or a utility knife, so that the block is round. Rinse the block under water to wash away the crumbs left from carving. Pat it dry with a cloth, then allow it to dry completely before using it.

Mix Ink:

Mix thoroughly with a plastic spoon (if they don't mix the ink very well, streaks may appear in their print).

Test Print:

1. Place the T-shirt or cloth scraps on your work surface. Scoop a tablespoon of ink onto a paper plate. Roll the foam brayer through the ink until the brayer/roller is evenly coated. Roll the brayer across the surface of the stamp, coating it evenly (they may need to wipe the edges of the inked side of the block). Turn the stamp upside down and hold it over the fabric.
2. Lower the stamp slowly, so that it touches down evenly on the fabric. Press down an all areas of the stamp, giving the ink several seconds to soak into the fabric.
3. Lift the stamp and set it, ink-side up, on the work surface.
4. If the print is too light, either more ink is needed on the stamp's surface, or more pressure is needed when pressing the stamp to the fabric.
5. If excess ink is pooling around the crevices, and roll on a lighter coat for the next print.
6. Continue making test prints, reapplying ink to the stamp and wiping excess ink from the edges between each print.
7. When their prints come out clean and even, have students write down the amount of ink used as well as the time and pressure needed. *Note: If at this point they notice that parts of the stamp were not carved well, wash it and make adjustments.*

Print:

1. Lay the shirt (or other fabric) on the work surface.
2. Fold a piece of newsprint to lie flat between the layers of the T-shirt (preventing ink from seeping through).
3. Reapply ink to your stamp, and wipe away any excess from the edges.
4. Position the stamp over the fabric, approximately 3" down from the center of the neck.
5. Lower the stamp and print, holding it firmly as they did earlier, then lift. Let the ink dry completely and then iron the fabric on high heat to set the ink and make it permanent.

Clean up:

Wash the rubber block or potato stamp under water, rubbing off the excess ink with your fingers or a brush. Pat it dry with a cloth, and then allow the stamp to air-dry completely before using it again. Wash the roller/brayer under water to remove all the ink.

Stenciling & Creating Fabric Art with Stencils

Tools and Materials

A stencil can be made out of almost anything flat that can be cut. Be it's important to choose a material that will work well with your desired printing surface. It is also important to think ahead about the size of the object you plan to stencil. If you make a small stencil for a big area, it could easily become a very time-consuming project! Following is an overview of the materials and tools used in the projects in this chapter.

Freezer Paper

Freezer paper is a medium-weight paper with a glossy coating (a thin layer of polyethylene) on one side. It is traditionally used to wrap food for freezer storage, but it also works exceptionally well as a stencil on a fabric because the glossy side sticks to fabric when ironed so that ink cannot seep under it. Freezer paper can be used on almost all fabrics that can be safely ironed. Large sheets give flexibility in terms of the size of the stencils that can be created.

Contact Paper

Contact paper (also called shelf-liner paper) is a plastic-coated paper with an adhesive backing sold at hardware and art supply stores. It is good for stencil-making because the tackiness of its adhesive side is strong enough to stick well to many surfaces (such s fabric, wood, and walls) but not so sticky that it is hard to remove or leaves a residue (however, you should always test a small piece before starting a project). Contact paper cannot be used to print on paper since the sticky side of the stencil will tear the paper when you remove it.

Mylar

Mylar is a trademarked polyester film commonly used for stencil-making. It is sold at art supply stores in a variety of thicknesses. Medium-weight Mylar 5 mil, may be labeled as 3-7 mil, because it is easy to cut and sturdy enough to use over and over. Very thick Mylar can be hard to cut and very thin Mylar can tear easily. Since Mylar is transparent, when you use it to make a stencil, you can often eyeball its placement on a printing surface. Lightly tinted or fogged Mylar stands out against the printing surface' if the Mylar is completely clear, it's hard to see where the stencil begins and ends. One benefit is that Mylar stencils can be used over and over unlike contact paper and freezer paper stencils.

Hole Punch Tool and Mallet

A hole punch tool (also called an eyelet tool) looks similar to a utility knife, but has a small circular opening at the bottom. It is used to make perfectly round holes in flat materials. It is similar to a regular paper hole puncher except it can be positioned anywhere on the material rather than just at the edge and usually comes with multiple attachments for different sizes. The blade on a hole punch tool does not need to be sharpened, but periodically the tip can get clogged, but can be cleaned out using the tip of a small pair of scissors.

To cut with a hole punch tool, hold the tool between your fingers and thumb like an ice cream cone, then strike the top of it several times with a rubber mallet with medium force to drive the circular opening into the stencil material. It can take some practice to get clean holes—striking the tool too hard can prevent the hole popping out of the sheet.

Scissors

When cutting a stencil design out of any material, it's important to use sharp scissors to get clean cuts. Vary the size of the scissors based on the size of the shapes they're cutting.

Utility Knife

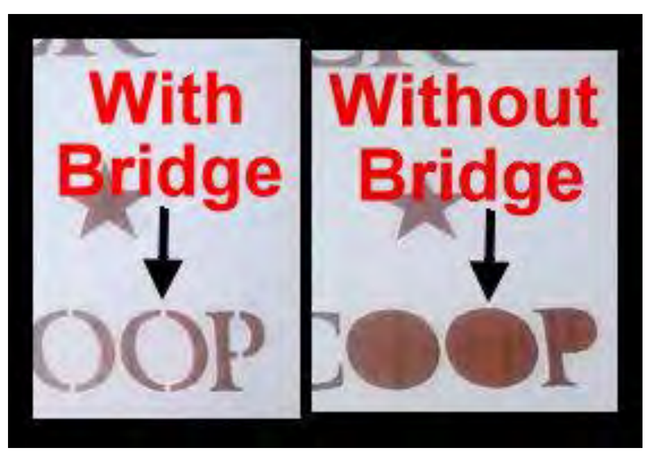
A utility knife is a penlike tool with a small, sharp, removable blade mounted on its tip; it is often referred to by the brand name X-acto. To use a utility knife, hold it like a pencil at a forty-five degree angle from the work surface and pull toward the body to cut. To get a clean cut at an edge or corner, make an X or a plus sign at the join, with each leg extending a bit in the opposite direction, but be especially careful in areas where the shapes are close together.

Inks and Paints

The choice of which kind of paint or ink to use with a stencil is always based on the material you are printing onto and the desired effect. Using acrylic fabric ink and oil-based spray paint for stenciling on fabric. Spray paint is especially well suited for stenciling because it is distributed in a then even layer.

Standard vs. Reverse Stencils

There are two types of stencils: standard and reverse. A standard stencil is created when the design is cut from the center of the sheet of materials with a utility knife. The center section is discarded, the outer portion becomes the stencil, and ink is applied to the open space left on the inside. A reverse stencil is created when a design is cut from the center of a sheet of material and the outer portion of the sheet is discarded. The center section becomes the stencil, and ink is applied around it.



Standard stencils are limited by the fact that all parts of the design must be joined in order to be functional. Parts of a design that are not connected to the rest of the stencil are called islands. These can be connected to the rest of the stencil with bridges, which are narrow pieces of the stencil material that connect the island to the stencil. The ink of an "R," for example. If you were to cut out an "R" in the middle of a piece of paper with a utility knife, the “R” would fall away from the stencil, but the rounded shape at the top of the “R” would not be attached to the stencil. To make sure that the rounded shape (the island) stays connected to the top of the “R” you would need to leave a small piece of the stencil uncut, creating a bridge between the stencil and the island.

Mylar Stencils Project

Materials:

- 18”x24” sheets of 5ml tinted Mylar
- Oil based Spray paint or other appropriate paint (see below)

Tools:

- Self-healing cutting mat
- Hole punch tool with attachments
- Rubber mallet
- Repositionable spray adhesive
- Latex gloves *(to protect hands from paint while repositioning the stencil)*
- Masking Tape
- Protective masks (if using spray mount)
- Transparent Tape
- Scissors
- Water-soluble fabric marker
- Newspaper or drop cloths
- Newsprint paper
- Paper Towels
- Nail polish remover

Making a Mylar Stencil

To transfer a stencil design from paper onto Mylar, place the paper underneath the Mylar and tape the two sheets together to held them in place. Cut the design out of both sheets at the same time, then discard the paper layer. If you don’t want to ruin the paper layer, place it under the Mylar, trace the artwork onto the surface of the Mylar with a thin-tipped permanent marker, then cut along the lines.

Mylar can be cut with a utility knife fitted with a shrp blade, sharp scissors, or a hole punch tool. If making a standard stencil (with the design cut out in the center of the sheet), you’ll probably need a utility knife or hle punch tool since you’ll be cutting into the middle of the Mylar, but if you’re making a reverse stencil (where the area around the design is discarded), you can often cut with scissors.

Make the design as complex as long as you like as long as they have the skill and patience to cut it out. To get a sense of what is possible, have students practice cutting shapes out of Mylar before starting a project.

To create their own stencil design with a hole punch tool, first sketch out a line drawing, then trace dots over it by hand or computer. Make sure the dots in your design are the size of your hole punch tool tip, and make sure not to place them too close together.

Printing with Mylar Stencils

To hold a Mylar stencil firmly in place so it doesn't shift while you're printing, apply an adhesive, such as spray mount or dry mount. You can also tape a Mylar stencil in place, but because the stencil will not lie firmly against the printing surface this way, some ink or paint may bleed under it.

Mylar stencils do not require specific types of ink or paint, so make that choice based upon the requirements of the printing surface. For instance, if they are stenciling on fabric that will eventually need to be washed, use ink intended for fabric.

The adhesive can be left on the Mylar stencil between uses. To store properly, place the sticky side of the stencil on a paper towel or piece of wax paper. When ready to use the stencil again, reapply a new coat of adhesive. The sticky residue from both spray mount and dry mount can be removed by rubbing mineral spirits or paint thinner on the surface of the stencil with a rag or paper towel.

Clean Up

Wipe the stencil with nail polish remover and a paper towel to remove the paint (if planning to use it again). The paint on hands can also be removed with nail polish remover if gloves weren't worn. Store the stencils sticky side down, on wax paper or a paper towel, or remove the adhesive with mineral spirits or paint thinner.

Modern Silk Screen Printing Begins

The screen printing process that we know of today emerged in the early 1900s when a man from Manchester, England, Samuel Simon, received a patent for using a silk screen fabric as a printing screen. Simon patented this process of printing through a silk screen, which guaranteed a higher tensile strength and better size stability. Simon's process also used rubber blades, or squeegees (like the squeegees used to clean windows, but a piece of cardboard or any stiff material with flat edges can be used in a pinch, though squeegees are ideal), to push the ink through the screen, another technique which is still used today. The invention was coined the term silk screen printing. It was originally used as a popular method to print expensive wall paper, printed on linen, silk, and other fine fabrics. Western screen printers developed reclusive, defensive and exclusionary business policies intended to keep secret their workshops' knowledge and techniques.

Originally a profitable industrial technology, screen printing was eventually adopted by artists as an expressive and conveniently repeatable medium for duplication well before the 1900s. A group of artists who later formed the National Serigraphic Society coined the word Serigraphy in the 1930s to differentiate the artistic application of screen printing from the industrial use of the process. "Serigraphy" is a combination word from the Latin word "Seri" (silk) and the Greek word "graphein" (to write or draw).

It was not until the First World War that screen printing took off in America. The process was used for printing flags and banners. The use of photographic stencils at this time made the process more versatile and encouraged wide-spread use. The actual use of silk for screens was discontinued in the mid-1940s during the Second World War because of its use in the war effort for parachutes and other uses. Since then a polyester material has been used for the screen mesh and other improvements have been made in the presses, inks, and chemicals used. Otherwise the same basic screen printing process patented by Simon is still used today.

Technique: In the simplest of terms screen printing works like this: A stencil is affixed to a mesh fabric that has been stretched tightly over a frame, much like a painter's canvas. The entire frame is laid over a printing surface, and ink is spread across the screen with a squeegee, so that the ink seeps through the screen in the parts that aren't covered by the stencil, is moved across the screen stencil, forcing or pumping ink past the threads of the woven mesh in the open areas, and the design is printed on the intended surface. The screen mesh is what differentiates screen printing from basic stenciling; the mesh distributes the ink evenly onto the printing surface, making the prints much more precise and consistent than those produced by a stencil alone. Therefore, screen prints can be quite detailed.

For every color intended to be applied, a separate screen has to be used with a different area blocked out each time. The artists must then wait for the ink to dry. This process is sometimes helped along with the use of an electric fan before they can apply the next color.

Water based ink is often used for silk screening, though oil-based inks are available. The water-based generally end up with a softer feel than oil-based. Because of evaporation water-based inks dry out as the water evaporates, giving you only about 15 minutes to work with them at a time. However, there are liquid retarders (a chemical that slows down drying/evaporation) when you mix the ink you gain 15-30 minutes of additional work time. If the ink begins to dry in a screen it MUST be washed out immediately or the screen will be ruined. Usually the ideal consistency for water-based ink is about that of melted ice cream.

Stencil It

Screen printing involves creating a stencil (printers call this a "screen"), and then using that stencil to apply layers of ink on the printing surface. Each color is applied using a different stencil, one at a time, combined to achieve the final look.

Screen printing is the best option for designs that require a high level of vibrancy, when printing on dark shirts, or specialty products. The ink in screen printing is applied thicker than digital printing, which results in brighter colors even on darker shirts.

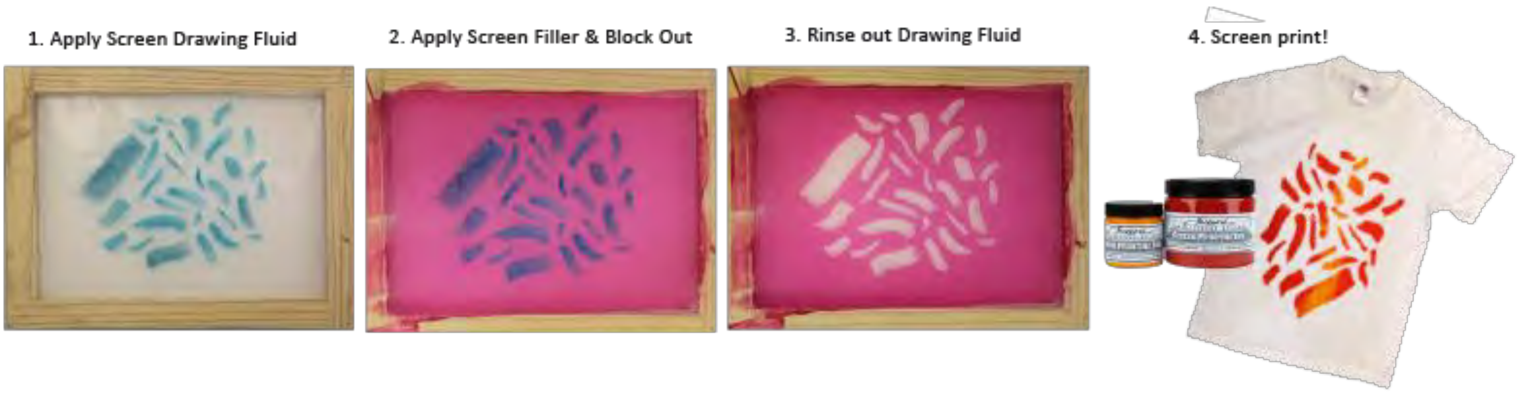
Stencils are also created using drawing fluid and screen filler, which are special inks that are used together to create a stencil on a screen, but they don't create the design on the printing surface.

Drawing with Fluid

Drawing fluid is a fascinating way to create a stencil for screen printing. The artist traces a design with a pencil onto the screen, and then paint over the lines on the screen with drawing fluid (a thin, water-soluble ink) thinner to let brush strokes show, and thicker for a more opaque print. If not happy, you can simply rinse it away, let the screen dry, and start over.

Once happy with the design, you let it dry completely. This process can be sped up with a hairdryer. Once dry the screen filler (a thicker acrylic ink that adheres to the screen and cannot easily be washed out) is squeegeed across the screen and let dry completely.

Next you run the screen under water, the drawing fluid washes out but the screen filler stays in place, creating a stencil. All of this happens because the drawing fluid and screen filler won't mix together or occupy the same holes in the mesh, so only the holes of the mesh surrounding the drawing fluid are filled in with screen filler. Because the drawing fluid is applied with a paintbrush, the print often shows the brushstrokes.



Magic of Mesh

Mesh is really where the magic of screen printing happens—the way it distributes the ink onto the printing surface is what gives each print such precise results. Like bed linens, mesh is available in a variety of thread counts, and the number it is assigned represents the number of threads per inch. For example, if you use 12xx/120 polyester mesh, an all-purpose medium weight mesh, that means that the screen contains 120 strands per inch. If you look at screen mesh under a magnifying glass, you will see a grid, with a magnifying glass, you will see a grid, with wider spaces if there is a low thread count, and tighter spaces for a higher thread count. Ink flows more easily through low-thread-count-mesh than high-thread-count mesh, so the detail of the created design is less fine. Lower-count-mesh often works better on textured surfaces because more ink can pass through and coat the uneven, absorbent fibers.

Screen mesh can be used over and over again if it is cleaned and cared for properly. It needs to be replaced when the threads begin to break down or if ink had dried in the holes, which is done by removing the screen and using a staple gun to attach a new stretched screen.

Uses: Silkscreen printing is used for a variety of purposes, both artistic and commercial. Artists have been using the process since the early -1930s. Promotional materials such as posters and stickers are commonly made using the silkscreen process because of the fairly low cost involved. Silk screens are generally thought to be more artistic than commercial printing, as they are done mostly by hand. Many clothing companies silkscreen products such as T-shirts, sweatshirts and baseball caps. Printing companies often still use the silkscreen process to make signage and banners for other businesses.

Screen Printing Art

Artists use silkscreens as a way to produce multiples of a design, and the prints in a series are considered original enough that each one is signed and numbered by the artist. When Andy Warhol began screen printing his work in the early 1960s, some people in the art community objected strongly because they said he wasn't doing art, he was doing "mass production." While screen printing is a great way to make precise multiples of a design, the process is still done by hand, so slight differences make each and every print unique.

Famous Artists

- Pop artists and creators of Op art during the 1960s and 1970s such as Andy Warhol, Roy Lichtenstein, Victor Vasarely and Robert Rauschenberg helped to make screen printing into a new art form that has held its own and rightly earned a place in contemporary art history. Silkscreen printing remains popular for emerging artists working in a variety of styles.
- The most expensive silk screen poster was created by Andy Warhol in 1963, titled the Eight Elvises, which sold for $100 Million in 2009.

The Printer's National Environmental Assistance Center says "Screenprinting is arguably the most versatile of all printing processes. "Since rudimentary screenprinting materials are so affordable and readily available, it has been used frequently in underground settings and subcultures, and the non-professional look of such DIY culture screen prints have become a significant cultural art seen on movie posters, record album covers, flyers, shirts, commercial fonts in advertising, in artwork and elsewhere.

Materials:

- Sheets of 10"x14" off-white printmaking paper
- Silk screen frames
- Water-based screen printing inks

Tools:

- Old blanket or towels
- Newsprint paper
- 2"-wide masking tape

- Soft-lead pencils
- Screen drawing fluid
- Screen filler
- Silk screen retarder
- 1/8" paintbrush
- Squeegee with 10" (or wider) blade, for screen filler
- Scrapers
- Plastic spoons
- Paper or plastic cups

Screen printing: Basics

Setting up Your Work Space:

Screen printing is best done at a large table, or on the floor. Working in cramped spaces slows down the process and leads to mistakes.

When printing small or medium sized objects, it works well to work at a large table. Protect the surface of the table by covering it completely with newsprint or kraft paper. For large objects, set up a similar work area on a clear space on the floor, cleaning the floor so that dust doesn't fly into the wet ink.

In the center of the work space, over the kraft or newsprint paper, lay down a thin blanket (ex. an old wool blanket from a thrift store) or an old towel to create a cushion. To the right of the printing surface set four paper or plastic cups upside down, onto which the screen can be placed between prints. Set a sheet of newsprint or newspaper by the cups so the squeegee can be placed down between prints.

To the left of the printing surface, at a safe distance from the wet screen and squeegee, keep the material on which the image will be printed.

After each print, place the printed material on a clean surface in another area of the room, away from the table. Keep a scraper nearby, a roll of paper towels on the table for wiping hands, and a garbage can nearby for the soiled paper towels.

To keep the process moving it may be best to have students work in partners. One person holds the screen frame in place while the other works the squeegee. One person also picks up the printed material and places it somewhere to dry while the other sets up for the next print.

Prepare Screen

Have students choose the photocopy of the artwork they want, or create their own design onto 8 ½" x 11" white paper. Set the silk screen frame on the work surface, mesh side down. Place the artwork, print-side DOWN, in the center of the screen, and tape it in place on all four sides. Turn the screen over. If using screen drawing fluid, using a soft-lead pencil, trace the design onto the mesh. Remove the paper and tape, and discard them.

Apply Stencil to Screen

1. Place the screen, mesh-side up, over a sheet of newsprint.
2. Shake the jar of drawing fluid to mix it thoroughly.
3. Open the jar and dip the tip of the paintbrush in the drawing fluid.
4. Paint along the design on the screen. Let the drawing fluid dry completely, leaving the screen in place on the newsprint.
5. Shake the jar of screen filler to mix it thoroughly. Open the jar and scoop several tablespoons of screen filler onto the screen, in a line along one of the shorter sides.
6. With a larger squeegee, spread the screen filler **thinly** and evenly across the entire screen. *One even layer of screen filler is enough—spreading it repeatedly can make it difficult to wash out the drying fluid later.*
7. Leave the screen in place and let the screen filler dry completely, which can take several hours. *This can be speeded up somewhat, if necessary, with the aid of a hair dryer.*

Taping a Screen:

To prevent ink from getting on the frame and to make it easy to clean the screen, tape the edges (where the mesh meets the frame), as follows:

1. Place the screen on the work surface, mesh side down.
2. Along all four sides, press strips of 2"-wide masking tape along the inside edges of the frame, with half of the tape on the mesh, and half on the frame.
3. Turn the frame over and, along all four sides, press additional strips of tape over the groove where the mesh is attached to the frame.

Mix Ink

Mix colors thoroughly with plastic spoons in cups, if you don't mix thoroughly streaks can appear in the prints.

Screen Printing

Once students have applied their stencil; using one of several methods ex. paper, drawing fluid & screen filler, or photographic emulsion method; taped the screen's edges, and set up their area, printing can begin.

1. Lay the material you want to print on the work surface. Set the screen, mesh side DOWN, on the material.
2. Scoop ink onto the screen from the cup with a plastic spoon and put it in a light above the design. (Designs MUST be 2 inches smaller on each side than the size of the screen.)
3. Hold the screen firmly in place with one hand, and the squeegee firmly in place with the other hand. The rubber blade should be at a forty-five degree angle on the mesh, above the line of ink. Using pressure, drag the squeegee down the surface of the mesh toward you, pulling the ink across the screen and forcing it through the holes in the mesh.
4. Turn the squeegee and push the ink AWAY from you, using the same side of the blade.

5. Repeat this motion several times, going up and down the screen.
6. When you are finished with a print, drag the squeegee across the screen again, but with no pressure. This is called flooding the screen, and it leaves a layer of wet ink that keeps the ink from drying in the screen between prints.
7. Once the screen is flooded, lift it off of the printing surface and set it, upside down, on four paper or plastic cups. Make sure that the cups do not touch any of the stencil areas. Do not set the frame directly on the table or ink might spread on the underside of the screen and ruin your next print.
8. 8. When the ink starts drying on the screen, clean it immediately.

Note: The first few prints are usually soft and not fully printed, so silk screens always need to be warmed up on a test material to get the sink flowing evenly through the screen.

Cleaning a Screen

1. When finished with a printing session, or when the ink is beginning to dry, wash the screen immediately in a deep sink or bathtub. If water-based ink is left to dry, it will permanently harden in the screen and ruin it.
2. Clean both sides of the screen with water, mild detergent, and a sponge or soft brush. The mesh will stay attached to the screen.
3. A sink spray-nozzle attachment is useful during this process, hold it right up to the screen.
4. When you think the screen is clean, hold it up to a light and check that all the holes in the mesh are clear of ink. Ink can sometimes leave a haze of color on a screen, but the haze does not clog the holes in the mesh and it does not need to be washed off. Using a rage, dry the screen and squeegee, and allow them to air-dry completely before using again. With proper cleaning and care, screens can be used over and over again.

If you used drawing fluid and screen filler to create a stencil:

Like other screen printing methods, a printing session using a screen filler stencil can last as long as the ink stays wet in the screen. When the screen-printing ink begins to dry, have students wash out the screen right away (if water-based ink is allowed to dry in screen mesh, it will RUIN the screen). A screen filler stencil can be used over and over, and will stay intact through washings. This method can be used on almost any surface.

If they want to reuse their screen later to make a new stencil, remove the screen filler by wetting the screen with water, rubbing a small amount of concentrated liquid laundry detergent onto the screen, and rubbing with a brush.

Let the screen sit for approximately five minutes, then scrub again under water using a soft brush, ex. old toothbrush. Repeat, if necessary.

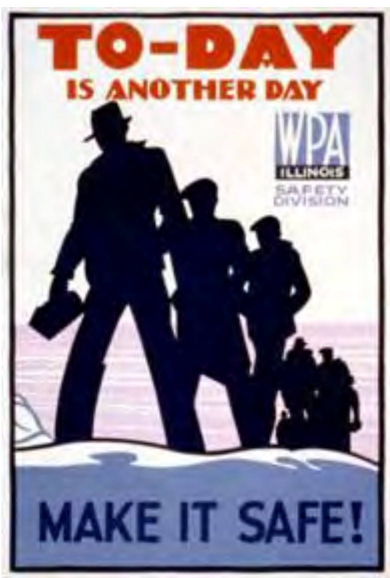
To save the ink, place it in an airtight container, but do not pour it back in the original ink container if it has been mixed with retarder.

Meshed Histories: The Influence of Screen Printing On Social Movements

Article by Lincoln Cushing *May 26, 2009.*

Just like clothes or cars, media can come in and out of fashion. Screen printing—or serigraphy, as it's called in finer art circles—has been a standard commercial process for more than a century. As a reproduction technique, it has many wonderful qualities. It requires very little in terms of equipment, and even that can be easily made by hand; it is easy to teach and to learn; and it's very well suited to very short runs of large format objects. It seems like an obvious choice when looking for ways to create prints for the public. Yet there have been at least two periods in history when screen printing was "discovered" by artists—the first was in the United States during the mid-1930s, under the Federal Arts Project of the Works Progress Administration (FAP/WPA), and the second time during the 1960s.

When Public Art Ruled



Screen print, Illinois FAP/WPA, 1937 (Library of Congress).

Between 1935 and 1943 the FAP/WPA was the first, and so far, the last, great effort to put public funding into the arts. It was primarily designed to provide jobs for unemployed artists—at the beginning, 90 percent of the artists had to come from the relief rolls. As an important secondary impact it brought art and artists to the breadth of America. Teaching how to make art was a national priority, and printmaking was an obvious approach. However, conventional art techniques such as lithography or engraving posted pedagogical and technical challenges, and screen printing quickly emerged as a productive choice.

The Silk Screen Unit of FAP/WPA was created in 1939 to promote public interest in this new medium. Among the major artists involved were Elizabeth Olds, Harry Gottleib and Riva Helfond. Their job was much more than to create a field of work in difficult times, but also to start a forum for proselytizing about printmaking as a tool for social democracy. Olds, an advocate for screen printing, laid out the situation thusly:

Since Currier and Ives there has been no comparable development… The mass production capacity of these multiple original works of art in color, with their unique artistic qualities as pictures… requires a new exhibition and distribution program in order that this Democratic Art may be made available to a large audience and buying public.

—From Radical Art: Printmaking and the Left in 1930s New York, by Helen Langa, University of California Press, 2004, p.221

The 1942 technical manual *Silk Screen Stenciling as a Fine Art* featured a Rockwell Kent introduction that enthused about this powerful medium:

"The stencil process is an ancient one, as the authors of this book reveal. The silk-screen stencil, which is the particular subject of the book, is a modern and, it is claimed, American development of this process that is of revolutionary importance. It removes from the craft of stenciling its serious technical limitations, endows it with the freedom of the artist's brush or pencil and makes it a medium for the expression of those subtle values that distinguish what we term Fine Art from its cruder relative, commercial art. It would be of disservice to my country not, at this time, to deplore our own national neglect of our own silk-screen stencil process in this day when nationwide visual, educational propaganda is a matter of such desperate necessity."

The 1960s: Two Revivals

"Support the factory occupations for a peoples' victory," screen print, Atelier Populaire No. 1, 1968 (courtesy Shannon Sheppard).

Paris, 1968

Fast-forward thirty years: The United States has emerged from the Second World War as a global superpower. The Cold War—and its domestic counterpart, McCarthyism—has forced political activists into hiding. But the civil rights movement in the South proves to be a harbinger of things to come, and following 1964's Free Speech Movement, the gloves are off. All sorts of social change movements come out of hibernation—antiwar, anti-imperialist, labor, women's rights, you name it. And their activism requires media. Once again, art students in schools around the world find that they haven't been taught a printmaking medium that meets their needs.

Perhaps the iconic representation of 1960s poster making was the output from various workshops in Paris during the worker-student strike during the spring of 1968. Art students from several colleges barricaded themselves in and created hundreds of graphics that spewed through the streets. But their well-meaning efforts to turn training to practice fell with a resounding thud.

Lithograph, Atelier Populaire No. 1, 1968 (courtesy Gene Marie Tempest).

Poster scholar Gene Marie Tempest interviewed several of the key participants, and learned that the first poster, *Usines, Universités, Union* ("Factories, Universities, Union"), was a lithograph and it took all afternoon to make 30 copies. This clearly wouldn't do, and they turned to an "American technique": silkscreening. By the mid-1960s only a handful of French galleries were using it to reproduce artworks.

Artist/activist Guy de Rougemont, who had been a client of one of those galleries, brought colleague Eric Seydoux, who was familiar with silkscreening, to the Beaux-Arts school.

"The atelier members," recalls Rougemont, "were in their general assembly, and I stood up and said, 'Listen, I have recently discovered a much faster printing process that is possible with fewer materials. It's called silkscreening.' So they all turned towards me and said, 'Very well, you will be responsible for setting up a silk-screening workshop,' And so I said 'yes,' but I was thinking 'What a responsibility!' After all, I only had an amateur's knowledge of the process. So I left the school, and I just happened to run into Eric. I said this just happened, I agreed to set up a silk-screening workshop for our painter friends. The next day Eric and I went to see his boss [at Paris Arts] and he gave us large screens and some inks. And so

with Eric, who knew the technique very well, […] we arrived at the Beaux-Arts.

Buraglio confirms that "few people knew the process," but this was not a problem because according to Seydoux "it was very simple. I mean, everyone could learn the technique in a little more than a few minutes."

Silk-screening was key in both workshops' impressive poster output. Instead of thirty lithographs a day, the Beaux-Arts silk screening produced 100 to 200 posters per rig per hour, several thousand per night, depending on how many screens were in use. The Arts-Déco's production was more modest: also 100 to 200 posters per hour, but only two to three hours of printing per night."

—From "Anti-Nazism and the Ateliers Populaires: The Memory of Nazi Collaboration in the Posters of Mai '68," unpublished essay by Gene Marie Tempest

Harvard, Berkeley and beyond, 1969

Almost exactly the same scenario played out as the Harvard campus erupted over conflicts with the campus administration. Harvey Hacker, a student at the Graduate School of Design, found himself drawn into a movement where his skill set was much needed for publicity work. However, the school still taught classical art media, and screen-printing was not one of them. When pressed to crank out some strike posters, including a local version of the iconic clenched fist, the owner of a local art supply store—who happened to be a sympathizer from Europe—gladly gave silkscreen supplies to the ad hoc crew. Their posters and T-shirts quickly made national news and movement history.

By now, the wonders of this miracle medium were out of the bag, and activists embraced it with vigor. Here is a testimonial found in *Every Soldier a Shitworker and Every Shitworker a Soldier: Organizational Skills Handbook*, by the International Liberation School, Berkeley, October 1969:

The primary advantage of silk-screening over offset printing lies in its inexpensiveness for short runs. Runs of over 1,000 are more trouble than they're worth with the makeshift equipment that's available to us. Also, in a crisis situation (just let your revolutionary fantasies run wild) such as a blackout, power failure or press rip-off, it will be necessary to be able to print information, slogans, etc., manually. Since the process is relatively easy to learn, and the equipment easy to assemble and much easier to maintain than an offset, it is to our advantage to familiarize as many people as possible with silkscreening (revolutionary art springing from the people). Also, in our attempts to destroy fragmentation and alienation in work, we can see that a hand-screened poster is really a product of unalienated labor—there is a tremendous amount of satisfaction to be gotten from turning out beautiful, hand-done screened political posters.

Everywhere there was something going on—Mexico City, Boston, Berlin—tiny workshops cranked out untold numbers of posters and street graphics. Striking students at San Francisco State College, People's Park demonstrators in Berkeley, the film institute in Cuba—all participated in one of the mass unorchestrated effusions of independent popular visual culture ever seen. And it wasn't slowing down.

Posters then and now (l to r): Harvard strike workshop screen print on butcher paper, 1969 (courtesy Harvey Hacker); and Dignidad rebelde: The Art of Protest, screen print, 2009 (courtesy Jesus Barraza and Melanie Cervantes).

The Legacy

Political art history repeated itself in 1970. The May 4 National Guard killing of four student demonstrators at Kent State, as well as two students at Jackson State College, in Mississippi, and the U.S. invasion of Cambodia, resulted in massive community response. Art students all over the country directed their energy to producing social change posters, and they knew what to do. The workshop at the University of California, Berkeley was perhaps the most prolific, creating more than 400 works on diverse issues such as gay liberation, health care, opposition to the Vietnam war, support for political prisoners, demand for alternative educational models and community control of police. Even though by then some sympathetic offset print shops existed to do larger runs, the advantages of silk-screen printing were well known, making it the medium of choice for countless activist artists. In the mid-1970s, community-based workshops such as San Francisco's La Raza Silkscreen and Kearny Street Workshop sprang up. The rise of movement-friendly offset print shops, along with migration to other media, eventually dimmed the parade of posters coming out of these small *talleres*. But even today, screen-printed posters are still created at workshops in San Francisco, Chicago, Portland and Minneapolis. Much of the work is still collaborative and community-based, as a recent example by Oakland's Jesus Barraza and Melanie Cervantes demonstrates.

Today

Ask students what kind of protest art they have seen. For each example, identify what message the artist was trying to convey? What symbols were used? What effect did it have on them? On the community or country? How does a country's form of government affect the expression and influence of protest art? If students have difficulty coming up with examples, feature those included in this lesson.

Screenprinting has seen another revival with the Occupy movement where artists are creating images utilized by the people currently protesting. Occupy Wall Street is a movement of protests against a variety of issues, but most name corporate greed and the link between the US government and the US banking sector as their reason for protesting. After the financial collapse in 2008, the US economy was dramatically weakened, unemployment rose, foreclosures occurred, and the major investment banks of Wall Street were bailed out by the US government in hopes of stabilizing the economy.

Occupy Wall Street protestors said they want to expose and remedy this situation, and consist of many unaffiliated groups protesting together.

With some artists, the trend is to create signs that encourage the toppling of the entire American system while keeping it light, catchy, and fun! Others express anger and aim for optimism. All are aiming for impact, a big impact.

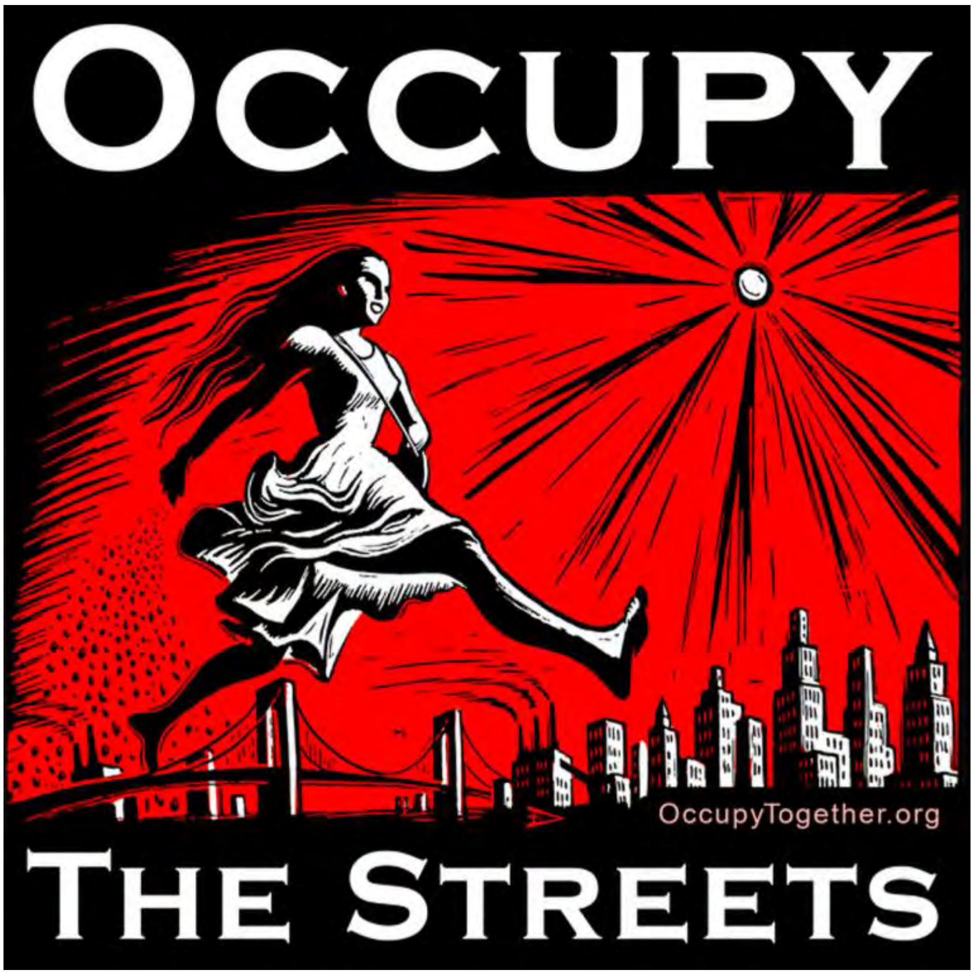
Art and design was a big part of Occupy Wall Street from the start. Adbusters, which is credited with starting the idea of Occupy

Wall Street in 2011, introduced a call to occupy Lower Manhattan with this graphic. (bull and dancer)

From there, the look of the movement became a little more homespun. In the first days of Occupy Wall Street, protesters at Zuccotti Park in New York City drew signs with marker on pieces of cardboard, often from discarded pizza boxes. Passersby who were curious what people were so angry about needed only stop for a minute and read the signs.

Gradually, the display grew bigger and the signs became one of the fixtures of the park. The protest spread globally, and artists in cities everywhere were beginning to contribute art, especially poster art, creating a visual language for their protest.

The poster language emerging from the Occupy Wall Street, like any art form, and especially screen printing, combines a lot of threads of the past into something new. The art is a product of Internet graphic design culture, which in turn borrows heavily from modernism and minimalism which seek clean sleek and simple designs. Also add dash of comic book art, a strong influence of rock-and-roll screen prints, and some knowingly ironic (tongue-in-cheek) use of Cold War and World War II propaganda iconography. The art and the language is earnest and bold; so far this isn't a movement that pokes fun at itself. At this point, what artists of the Occupy Wall Street movement are looking for, like any protestor, beneath the frustration and anger, is a sense of hope. That somehow they can make the future better with what they have to say, and that if they say it, someone will listen, and things will change. **Ask students if art can be an effective form of protest and a means for bringing about political and social changes. Ask those who respond to defend their answers.**

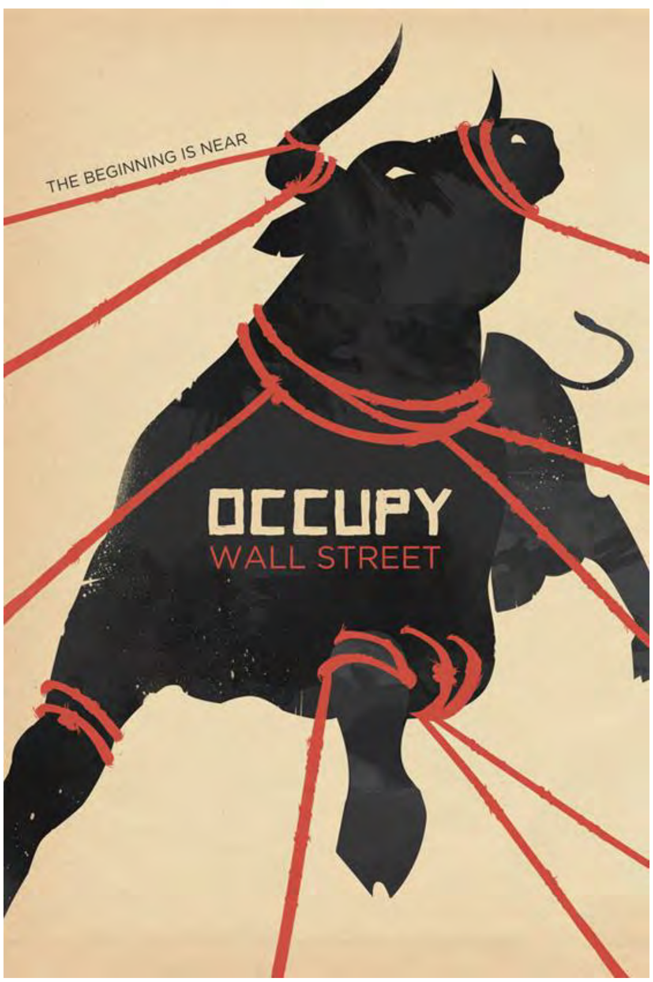


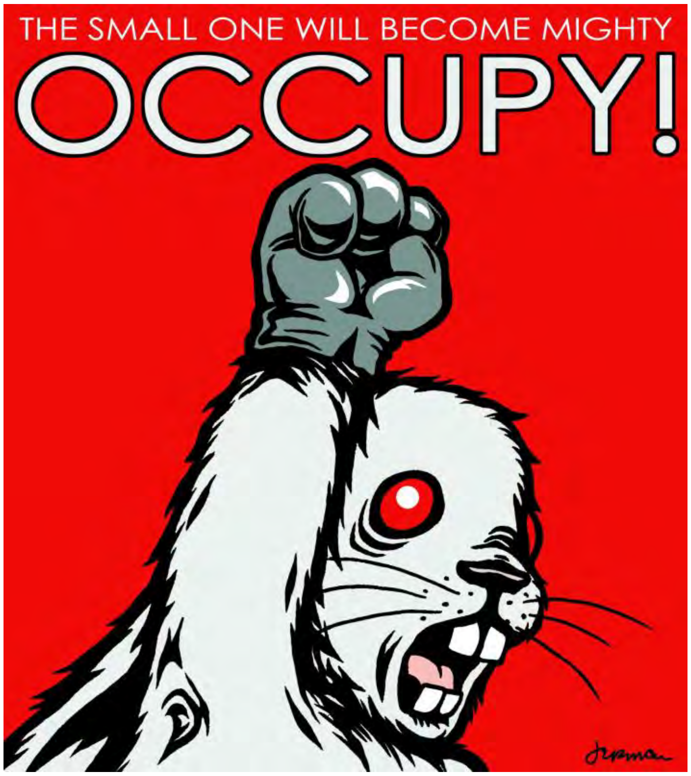
Silkscreening may never die, but if history is any guide, it will probably be forgotten, again. Here's looking forward to the next Renaissance.

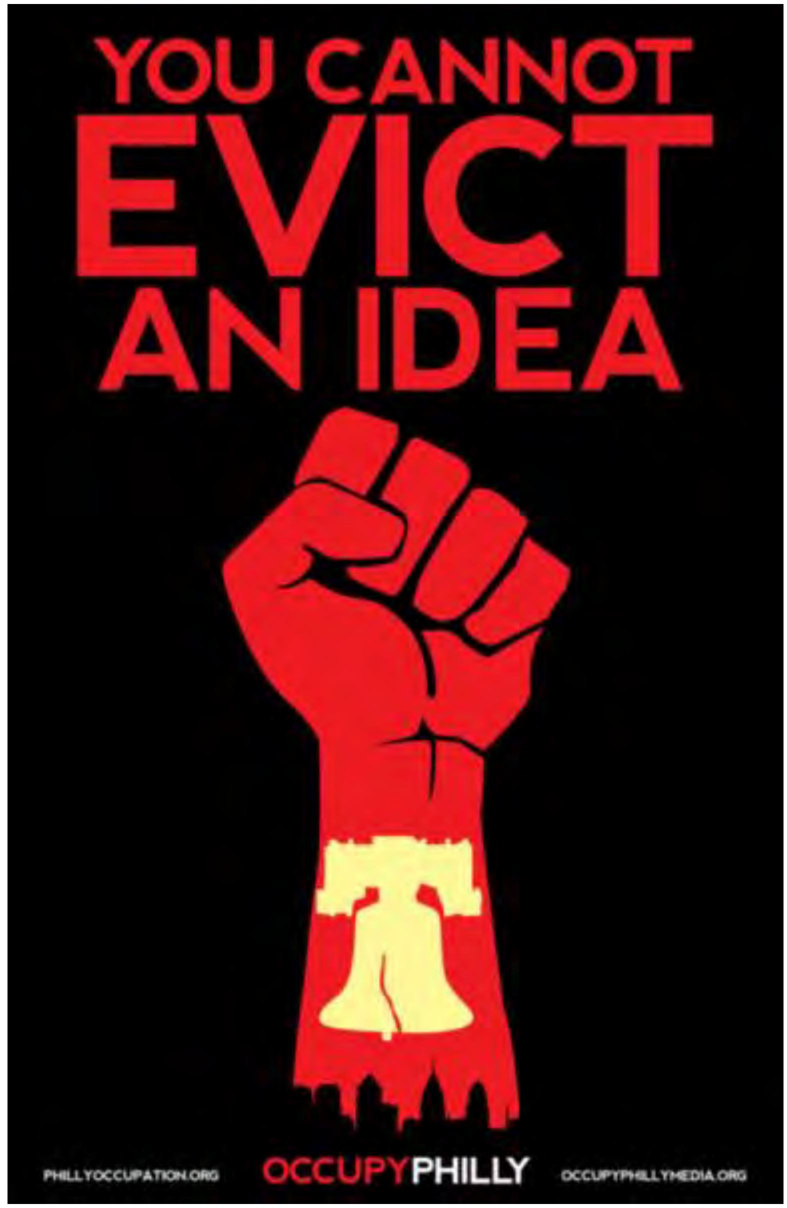
Do students think the First Amendment right to free speech does or does not protect artistic expression? Why or why not? Did students know there have been court cases related to protest art involving artwork and surrounding issues (e.g., censorship, artistic expression in public schools, political commentary, etc.?)


OCCUPY!


ZUCCOTTi
TIP
OF THE
ICEBERG
D. Loewenstein 2011


THE BEGINNING IS NEAR
OCCUPY
WALL STREET


THE SMALL ONE WILL BECOME MIGHTY
OCCUPY!


YOU CANNOT
EVICT
AN IDEA
PHILLYOCCUPATION.ORG
OCCUPYPHILLY
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WORTH
FIGHTING FOR

Speak UP & Listen!

The final project goal is for students to create a personal t-shirt or fabric design using different techniques they have used so far to create choose colors and symbols that have meaning and significance to them, create, templates and screen multiple elements to create a cohesive image. This is the perfect opportunity for students to take what they have learned and apply their knowledge of color schemes and positive and negative space. Students can draw from their beliefs, personal experiences, current events, or other sources to inspire their creations.

Silkworm Moth - adult on top of cocoon - just emerged - notice opening.

Silkworm Moth - caterpillar on mulberry leaf Copyright: © Dwight Kuhn - All Rights Reserved

Male and female silkworm moths, cocoon and eggs


© Dwight Kuhn

Silkworm Moth - eggs hatching into caterpillars. Copyright: © Dwight Kuhn - All Rights Reserved

Silkworm Moth - adult on top of cocoon - just emerged.


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Silkworm Moth - eggs on mulberry leaf

Close up of silkworm feeding.

Raising silkworms on mulberry leaves

Silkworm spinning cocoon.

Silkworm inside cocoon.

Silkworm Cocoons

Silkworm cocoons on frames at a silk farm

Cross section of silkworm in cocoon prior to pupation

Silkworm Pupating

Silkworm pupation in advanced stages

Final stage of silkworm pupation

Silkworm Pupa

Silkworm Pupae

Silkworm moths emerging from cocoons

Silkworm moth on cocoons

Male Silkworm Moth

Close up of female silkworm moth scent glands

Female silkworm moth releasing scent from abdominal glands