Lesson Title	Organic Chemistry in Dyes
Length of Lesson	1 day (90 minutes)
Created By	Hannah Box
Subject	Chemistry
Grade Level	10th
State Standards	Organic Chemistry 3a
DOK Level	DOK 1
DOK Application	Define, arrange, use, illustrate
National Standards	Physical Science: 9-12: B
Graduate Research Element	Dyes provide a great example of the kinds of complex molecules that can be built using organic chemistry.

Student Learning Goal:

Students will learn the basics of how dyes work and what is happening on a chemical level.

State Standards:

3b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
• Common uses of polymers and organic compounds in medicine, drugs, and personal care products
• Compounds which have the property to dye materials
• Petrochemical production
• Biologically active compounds in terms of functional group substrate interaction

National Standards:

Physical Science 9-12: B: The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.

Materials Needed (supplies, hand-outs, resources):

Several 5 gallon buckets, rubber bands, urea (H_2NCNH_2), large garbage bags, soda ash (sodium carbonate), disposable latex gloves, Procion fiber reactive dyes (many colors),

goggles, and plastic apron

Lesson Performance Task/Assessment:

Students will apply their knowledge of organic dyes by creating a dyed article of clothing

Lesson Relevance to Performance Task and Students:

Students will use organic dyes and chemistry to create a unique article of clothing.

Anticipatory Set/Capture Interest:

Discuss the history of dyes all the way back to when cave men discovered the first examples.

Guided Practice:

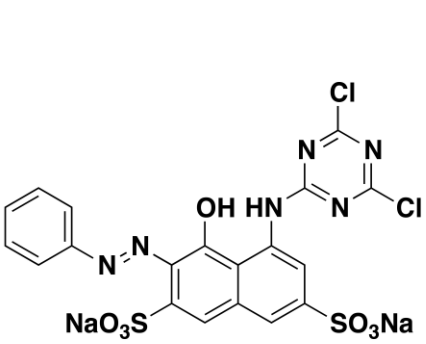
Chemistry is in everything that we do! Today we are going to learn how organic chemistry is a part of dyes. First, we need to learn a little about dyes. Some dyes, like the kind that you can buy at the store, really just stain clothes, so the dye washes out a little every time you wash the cloth.

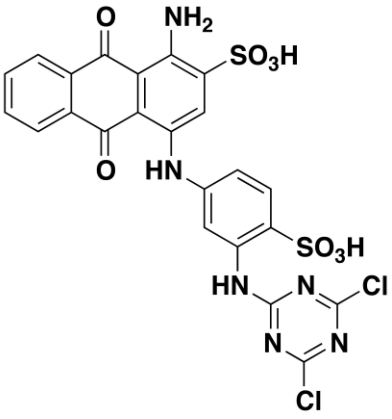
*Is this a chemical or physical change? Physical No new substances are formed. Chemicals not bonded together

A good dye actually attaches to the molecules of the fabric. The dye will not wash out.

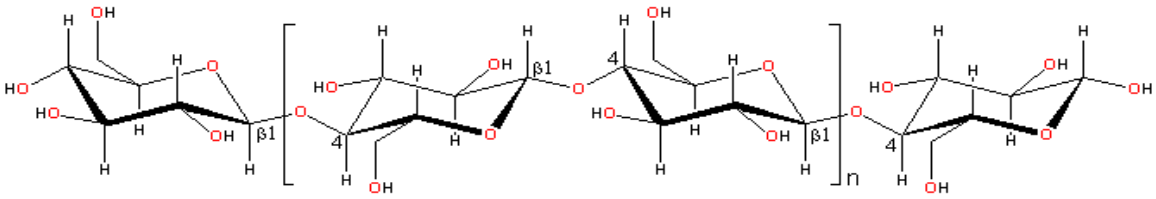
*Is this a chemical or a physical change? Chemical. A new substance is formed different from the original substances—different chemical properties

The dye molecules are made out of atoms of different elements such as C, H, O, S, N, Cl, and Na. These atoms are held together by chemical bonds and are arranged in different structures. Different dye colors are made out of different dye molecules. Each dye molecule is shaped differently and thus each different shape absorbs light differently. That's what makes the different colors. Show some examples of dye structures.





The fabric your clothing is made out of is also made of molecules. Cotton made of large strands of cellulose molecules, all twisted together. Cellulose is the same thing that wood is made of.



What we need to do is to prepare the fabric to allow for the bonding of the dye to the cotton. We will add another chemical. A high pH is needed to make the cellulose and the dye react together.

*So what should we add—an acid or a base? Base

We will add a chemical called sodium carbonate, Na_2CO_3 (known as soda ash) which is basic. This will allow the dye to attach to the cellulose permanently by forming a chemical bond.

Independent Practice:

Soak in the soda ash. Label your item with a permanent marker. Place it into the bucket of a solution of soda ash that has been prepared. Completely submerge it and be sure that it is soaked through Wring out most of the fixer solution from the shirt into the bucket. The fixer solution can be reused to soak additional tee shirts. Bring item to the dyeing station.

You must wear goggles, apron, and plastic gloves. The tee shirt should be wet but most of the water squeezed out. If too wet, the dye will be diluted.

Lay the shirt flat on the clean plastic tabletop. Try to get as many wrinkles out of the shirt.

Pick a pattern. Pleat, spiral, or fold the shirt in the desired pattern. See handouts for ideas.

Place 2 to 3 long rubber bands around the fabric across the middle to hold the fabric together and the folds in place. The rubber bands should not bind or squeeze the fabric, simply hold everything in place so that it doesn't unravel.

Make sure the area is clean. Place the shirt on the table and begin applying the dyes to the areas desired using the dropper that is in the dye. DO NOT mix droppers!!!!!!
Be careful when choosing colors. Orange + blue will turn brown. Suggestions: Don't put purple next to yellow or orange. This will also turn brown.

One thing to pay attention to is the amount of dye added. You want to get enough dye into the shirt so that white spots disappear, but too much dye will cause it to run and mix. Try to balance this. Spread the pleats apart and look. If you see white, add more dye.

When done with the front of the shirt, wipe the area clean with a clean paper towel, and flip the shirt. You can either apply dye to this side matching up the colors from the front or you can apply one color to the whole back. (This is a really neat shirt.)

Take a plastic bag and mark your name on it. Spread the bag open and place in the area designated by the teacher. Place the T shirt in the bag carefully.
Once the shirt is in the bag, do not move the bag until ready to rinse the shirt out the next day. Tie the bag. Allow the shirt to sit undisturbed for 24 hours.

Wearing gloves and goggles, take the bag to the sink. Remove the shirt. Rinse the shirt with cold water. Squeeze and rinse until no more dye runs from the shirt (This may take 5-10 minutes). Increase the temperature of the water to warm water. Continue to rinse for 5 more minutes. Squeeze shirt dry. Place shirt in new plastic bag. Suggestion—use 2 plastic bags to avoid leaking. Take home.

Immediately wash the shirt in cold water. Do not wash any other clothes with this shirt the first time. Dry the shirt in the dryer. The shirt is now colorfast and can be washed with dark clothes.

Remediation and/or Enrichment:

Remediation: Individual IEP

Enrichment: Have students look at organic dyes in a 3D software. Use as an introduction functional groups

Check(s) for Understanding:

Answer questions throughout the guided practice.

Answer questions on the handout.

Why do you think it was important to perform the procedure in that order?

Once the shirts have been unfolded, have students compare. Which fabrics held the dye better?

Does cotton grow in Starkville, MS?

Closure:

Students will learn about organic dyes and use them to create a dye pattern on their own clothing.

Possible Alternate Subject Integrations:

Teacher Notes:

The urea water must be prepared 1 day before used to dye. Prewash garments that are to be dyed.