

Title: Fibers, Dyes and the Environment

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Subject: Environmental Science, Material Science, General Science

Grade Level: 6-12

Standards:

NYS Intermediate Science: Standards 1, 4, and 7

NGSS: MS-ETS1-1, MS-ESS3-3

Common Core: RST.6-8.1, WHST.6-8.1

Schedule: 1 week for five hands-on station activities and 1 week for class case study exercise (intended for 50 minute periods)

CCMR Lending Library Connected Activities:



<p><u>Objectives:</u></p> <p>Students will learn about current research in materials science and nanotechnology that is being applied to solve real-world environmental problems.</p> <p>Students will be able to generate a coherent claim to an argument based on textual evidence by portraying different roles to demonstrate the complexity of wastewater treatment within a community.</p> <p>Students will be able to gather evidence and data from experiments to support their claim.</p> <p>Students will be able to write an argumentative essay to support their claim for an argument.</p>	<p><u>Vocabulary:</u></p> <ul style="list-style-type: none"> - Fiber science <p><i>Station 1: Process of Making Jeans and Tie-Dying</i></p> <ul style="list-style-type: none"> - Cellulose - Chemical Reaction - Acids - Bases - pH indicator - Covalent bond <p><i>Station 2: Water Pollution and Water Treatment</i></p> <ul style="list-style-type: none"> - Waste water - Filtration - Effluent - Fashion Revolution <p><i>Station 3: Waste Management and Sanitation in NYC</i></p> <ul style="list-style-type: none"> - Compost - Landfill <p><i>Station 4: Making Cotton Candy Fibers</i></p> <ul style="list-style-type: none"> - Fiber spinning - Nanofiber - Micrometer - Nanometer - Diameter - Sucrose - Morphology <p><i>Station 5: Enzymes for Water Treatment</i></p> <ul style="list-style-type: none"> - Enzymes - Substrate - Active site <p><i>Case Study exercise</i></p>
<p><u>Students Will:</u></p> <p><i>NYS Intermediate Science Standards –</i></p> <ul style="list-style-type: none"> - <u>Standard 1:</u> Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions. - <u>Standard 4:</u> Students will describe the 	<p><u>WEEK 1 MATERIALS:</u></p> <ul style="list-style-type: none"> - Stations handouts - Stations worksheet packet <p><i>Station 1: Process of Making Jeans and Tie-Dying</i></p> <ul style="list-style-type: none"> - Computer access to view short clip - “Making of Jeans” cards in envelope



<p>effects of environmental changes on humans and other populations.</p> <ul style="list-style-type: none"> - Standard 7: Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions. <p><i>Next Generation Science Standards –</i></p> <ul style="list-style-type: none"> - MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. - MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. 	<ul style="list-style-type: none"> - Tie-dyeing kit <ul style="list-style-type: none"> - Fiber Reactive dyes - Two 500 ml beakers - Washing soda - 100% cotton 4”x4” squares (20) - 6 oz. squirt bottles (3) - Rubber bands - A bag of beans - Water <p>Station 2: Water Pollution and Water Treatment</p> <ul style="list-style-type: none"> - filter paper or cheese-cloth - water bottles - sand and other residue in water - computer access for short video clip <p>Station 3: Waste management and sanitation in NYC</p> <ul style="list-style-type: none"> - Images of waste or recycled items - Computer access for short video clip <p>Station 4: Making Cotton Candy Fibers</p> <ul style="list-style-type: none"> - Cotton candy machine - Universal litmus paper - 1 package of hard candy - 1 package of sugar-free hard candy - Metric Rulers <p>Station 5: Enzymes for Water Treatment</p> <ul style="list-style-type: none"> - LEGO enzyme-substrate model - apple and lemon <p>WEEK 2 MATERIALS:</p> <ul style="list-style-type: none"> - Storyline packet of “Case study of Waste Management in Chromoville”
<p style="text-align: center;">Safety</p>	<p>Goggles, gloves, and aprons/lab coats should be worn during tie-dyeing activity (Station 1). It is recommended that the cotton candy machine should be operated by an adult or samples may be pre-made for students to observe during Station activity 4.</p>



Science Content for the Teacher:

This lesson was created based on research in a Fiber Science lab. The main goal of the activities in this lesson is for students to understand fiber formation, fabric dyeing, how enzymes can be useful for wastewater treatment, and methods of waste management.

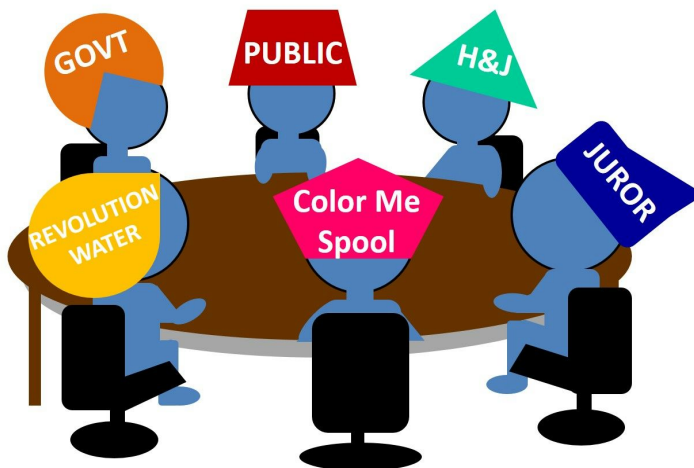
Nanofibers discussed in this lesson can be made by processes, such as electrospinning and force spinning. In electrospinning a jet of liquid polymer is pushed out through a syringe producing a continuous stream of fiber that is deposited on a ground collector at high voltage. In force spinning the polymer melt (solution) spins out of the center of a container and the fiber strands fling toward the sides as the center rotates. The nanofiber mats produced have many potentially uses from tissue engineering to wastewater filtration systems.

The focus of this lesson originated from current research in Dr. Margaret Frey's lab at Cornell University, where fibers are produced by electrospinning (a method similar to force-spinning with the addition of an electric field). In an effort to combat current problems with polluted waters near textile companies, enzymes known to degrade complex chemical structures (dyes) may be incorporated into fiber mats to serve for wastewater treatment.

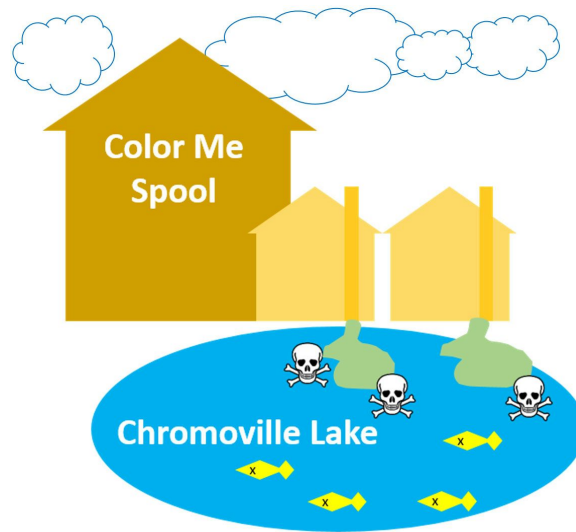
This lesson is comprised of two parts: (1) Station Activities on textiles, dyes, and waste water treatment and (2) Case Study of wastewater management in Chromoville. The station activities will teach students about fiber morphology, force-spinning, enzymes, waste treatment, and how color dyes react with fabrics. Using all the information they learned from the station activities, students will transition into the case study part of the lesson.

The Case study will focus on the complexity of an environmental issue. Students will have the opportunity to portray different characters for a community decision and think critically about each role at a roundtable meeting. The skills students will learn from this activity include public speaking, critical thinking, data analysis, and decision-making.

Chromoville Roundtable...



The purpose of the roundtable meeting is for representatives of the Chromoville government, the public, and industrial companies to talk about a current water treatment issue in their community. Chromoville is a city known for fabric production and dyeing. The Mayor is very concerned about the water scarcity issue rising worldwide and the need to keep their waters clean and safe for the citizens of Chromoville. He emphasizes that Color Me Spool provides employment for 40% of the population in Chromoville and supports it, however, is becoming concerned that the lake is different colors sometimes (based on phone calls from fishermen in the past year). The mayor wants more background on the current wastewater treatment process that Color Me Spool uses, and insists that they work with Revolution, a water treatment company that has very innovative technologies. H&J, a global fashion brand that receives much of its dyed fabric from Color Me Spool also attends the meeting.



Classroom Procedure:

Station Activities -

- 1) Engage students by asking “what country is your shirt made from?” as a Do Now activity.
- 2) Take a tally of the countries that their clothes are made from.
- 3) Introduce the story of Chromoville to students.
 - a. Before they make a decision for Chromoville, they must learn a little about fiber science and wastewater treatment.
- 4) Explain the procedures of each station activity to reduce the amount of confusion as students explore during the activity.
- 5) Assign roles for each student in groups of 4 for the Station Activities (facilitator, time-keeper, secretary, technician)
 - a. **Facilitator:** ensures that everyone in the group has a role and is on task.
 - b. **Time-keeper:** reminds group of the amount of time left during each station.
 - c. **Secretary:** ensures that all handouts are giving out during activity AND collected into the Group Folder at the end of each activity
 - d. **Technician:** ensures that all materials are present during the start and end of each activity. Ensures that materials are not damaged before, during, or after activity. Notifies teacher if there are damaged materials.
- 6) Students work in station activities for 20-25 minutes for each station.
 - a. Teacher circulates to facilitate students during activity.
- 7) When students complete all stations, summarize activity with an Exit Slip activity. Provide post-its to each student and ask them to choose one activity. Answer the following question about that one activity of their choice:
 - a. What did you learn from this station?
 - b. What did you like about this station?
 - c. What did you dislike about this station?

Case Study in Chromoville –

- 1) Assign roles for students who would like to participate in role-playing.
- 2) Provide role-playing students with Stakeholders Introduction cards.
- 3) Stakeholders introduce themselves to the class.
- 4) During this presentation, provide class with “who’s who?” worksheet so students may take notes about each stakeholder.
- 5) Prepare students to interview stakeholders by providing a list of interview questions that may be asked.
- 6) Using what they have learned from the introductions and interviews, each student (including the stakeholders) will take part in the “If I was Mayor...” silent discussion.
 - a. Student write about what should be the next steps the city should take in regards to the water treatment plan
 - b. After a response is written, each student passes their paper to a partner. Then student writes a response to the previous idea.



- c. Trade papers at least 3 times to allow a variety of ideas to circulate around the classroom.
- 7) Stakeholders meet in small groups to discuss what their next steps should be. Prepare to present in front of class their ideas.
- 8) Stakeholders engage in a roundtable discussion in front of the class.
 - a. Discussion may include what should be the next steps for the companies that are involved
 - b. The government may intervene with an overall plan for the city
 - c. The general public may also express their ideas for the city
- 9) At the end of all presentations, the class will agree on 2 possible solutions to the issue and participate in a secret ballot vote to determine the final decision.



Assessment:

Self-Assessment

4 3 2 1

Total: ____/32 pts

Station Activities

Activity handouts completed with effort and accuracy

Completed each station task on-time

Worked cooperatively with other teammates at each station

Completed all reading assignments and reflections related to each station activity

Actively participated in Chromoville Case Study

Wrote at least 3 responses to the “If I was Mayor...” during silent discussion

Wrote a coherent argument of your position regarding your decision regarding what the Mayor of Chromoville should do (5-¶ essay)

Included and discussed at least 3 pieces of textual evidence related to textiles, color dyeing, and/or wastewater management in position argument

Teacher Evaluation

4 3 2 1

Total: ____/32 pts



Resources:

- See attached documents for station activities and worksheets that correspond to the station activities.
- See attached documents for roles of the stakeholders in Case Study activity.

Reading Articles -

1. “The Environmental, Health, and Economic Impacts of Textile Azo Dyes:”
http://2014.igem.org/wiki/images/2/29/Goodbye_Azo_Dye_POSTnote.pdf
2. Pereira, L. and Alves, M. “Dyes - Environmental Impact and Remediation”:
<http://repositorium.sdum.uminho.pt/bitstream/1822/25109/1/Ch%25204%2520-%2520Dyes.pdf>
3. Chhonkar, P.K. et al., Journal of Scientific & Industrial Research, “Impact of Tannery & Textile Industries Effluents on Agriculture”:
[http://nopr.niscair.res.in/bitstream/123456789/26583/1/JSIR%2059\(6\)%20446-454.pdf](http://nopr.niscair.res.in/bitstream/123456789/26583/1/JSIR%2059(6)%20446-454.pdf)
4. Cornell University, “Electrospinning Cellulose Waste into Fiber”:
<http://www.sciencedaily.com/releases/2003/09/030911072323.htm>
5. Barker, E., Popular Science “The Problem with Indigo”:
<http://www.popsci.com/blog-network/techtiles/problem-indigo>
6. Friedlander, Blaine. “Nano-style sheets may aid health, shield ecosystem” Cornell Chronicle. Aug 12, 2015.
<http://www.news.cornell.edu/stories/2015/08/nano-style-sheets-may-aid-health-shield-ecosystem>

Extra Activities:

Other activities that may have stemmed from this lesson are suitable for students at higher grade levels:

- 1) Lesson on metric units and scale - diameter measurements of the fibers can be taken to incorporate metric unit conversions of centimeters into micrometers.
- 2) Lesson on enzyme demonstration - Saliva contain the enzyme, amylase, and can used to break down Starch packing peanuts.
- 3) Sociology Lesson on the complexity of the fashion industry using the film, “The True Cost” as a starting point for discussion.

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