

Spandex vs. Cotton

Unit: Chemical Bonding	Utah SEEd Standard / NGSS Performance Expectation: Standard CHEM.2.3 Engage in argument supported by evidence that the <u>functions</u> of natural and designed macromolecules are related to their chemical <u>structures</u> . Emphasize the roles of attractive forces between and within molecules. Examples could include non-covalent interactions between base pairs in DNA, allowing it to be unzipped for replication, the network of atoms in a diamond conferring hardness, or the nonpolar nature of polyester (PET), making it quick-drying. (PS1.A) (Each standard is a student performance expectation that includes all three dimensions of science.) NGSS Correlation: HS-LS1-6	Time: 65 minutes
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Access to all material for this lesson: [Link to lesson folder](#)

Anchor Phenomenon	Different fabrics have different functions because of the structure of the molecules used in them. Students act as consultants for a river rafting company, tasked with deciding if spandex or cotton is a better fabric for a cold, early-season river rafting trip. They must support their decision with evidence.
Driving Question(s)	As a river rafting company, would you recommend spandex or cotton fabric to your customers on a river rafting trip early in the season?
Performance Task	Students will rotate through stations looking at different properties of spandex and cotton and compare their structures and functions. Students will use this evidence to support their argument that different structures have various functions.



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Lesson Summary: The goal for this lesson is to have students investigate how the structures of macromolecules affect the functions of the macromolecules. The macromolecules the students will be investigating are cotton and spandex. They will perform a series of experiments to research the different aspects of the fabrics, then engage in arguments from evidence to justify their claim of which fabric would be better on a cold, early-season river rafting trip.

	Time	Guiding Question / Learning Objective	How are students answering the guiding question or meeting the learning objective?
 Engage	5 min	Guiding Question: You work for a river rafting company and need to recommend clothing to wear while rafting. You will need good evidence and reasoning for why your customers should follow your recommendation. Objective: Identify information about spandex and cotton and how they are made. Make an initial claim.	Students will use infographics about spandex and cotton to compare structures and functions of natural and designed macromolecules , specifically from what and how they are made. They will make an initial claim based on evidence gathered so far.
 Explore	35 min	Guiding question: How are the macromolecules of cotton (natural) and spandex (synthetic) similar and different? Six stations will enable students to investigate each fabric and tie their observations to molecular structures. More and better evidence will help students to improve their argument.	Students will rotate to six stations to collect information about the two macromolecules . Each station will provide information through experimentation or observations of different structures and functions of the molecules. Students will use the data to create an argument for which fabric is best for river rafting in cold weather.
 Explain	10 min	Consolidate and summarize information from the six stations. Help ensure students process the correct information needed to solidify their claim with good supporting evidence for their argument.	Students will relate the structure of the macromolecules to the functions of the fabrics as they consolidate and summarize the evidence collected at each station.
 Evaluate	15 min	Using the worksheet, students will write a final claim using their evidence gathered from the different stations as to which fabric to wear. Students will share their claim/argument with evidence and reasoning with another student. Objective: Write a final claim supported by evidence that will be shared with a student from a different group.	Students will write a claim/argument from the evidence that they have gathered to say why the structure of the fabric they chose would be better for their company to recommend to customers when river rafting.
 Elaborate	Time varies	Students will create a travel brochure, infomercial, or web page using evidence in a customer-friendly way to present their claim/recommendation for what kind of fabric to wear while on their river rafting trip.	Using spandex and cotton, students learn that chemical structures affect the functions of natural and designed macromolecules and then create an argument from evidence to recommend what river rafters should wear.

Three Dimensions Focused on in This Lesson

Disciplinary Core Ideas

(PS1.A): Structure and Properties of Matter
Electrical attractions and repulsions between charged particles (i.e. atomic nuclei and electrons) in matter explain the structure of atoms and the forces between atoms that cause them to form molecules (via chemical bonds), which range in size from two to thousands of atoms (e.g., in biological molecules such as proteins). The varied properties of the materials one encounters, both natural and manufactured, can be understood in terms of the atomic and molecular constituents present and the forces within and between them.

Students know and apply the Disciplinary Core Idea (DCI) of PS1.A Structure and Properties of Matter in their thinking and reasoning to communicate that:

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

Cross Cutting Concepts

Structure and Function: The molecular structure of a macromolecule (such as DNA, polyester, etc) is a result of the attractive forces and shape of the substructures (monomers, etc) between and within molecules. The structure provides various functions and uses.

Students think and connect through the Crosscutting Concept (CCC) to reason that:

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Science and Engineering Practices

Engaging in Argument from Evidence: Students engage in argument regarding the structure of a macromolecule and support their argument with evidence of its observable or measured properties.

Students do and use this Science and Engineering Practice (SEP) by:

- Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining what additional information is required to resolve contradictions.
- Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.



Learning Objectives

1. Engage in argument supported by evidence that the functions of natural and designed macromolecules are related to their chemical structures.

Related Knowledge and Skills from Prior Grades

Grade 6 Strand 2

Grade 8 Strand 1

Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions).

Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

CHEM Strand 1, 2

Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.

The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

6-8

Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.

6-8

Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

9-12

Knowledge of polar molecules and nonpolar molecules. Intermolecular forces causing attraction between different molecules.

Connections to Mathematics and ELA/Literacy Standards

ELA/Literacy Standards:

- **RST.11-12.1:** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.



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- **WHST.9-12.2:** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
 - **WHST.9-12.5:** Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.9-12.9:** Draw evidence from informational texts to support analysis, reflection, and research.

Materials:

Handouts	Lab Supplies	Other Resources
Student Worksheet Infographics for different stations Infographics for different stations (pdf version) - Print several of #1-4 for the Engage section class activity. Chemical Models for Compare and Contrast Station	- Cotton and Spandex Fabric Samples (Try to make sure the fabrics are of a similar weave; spandex or a swimsuit material works best) - Water - Weigh boats - Scales - Rulers - Thermometers - Flame source (matches, lighter, candle) - Tweezers - Droppers or pipettes	Cotton vs. Spandex PowerPoint Water rafting video links South East: San Juan Lunch Counter -- Snake River, Wyoming Lab Stations, Infographics: Teacher Instructions Argue from Evidence Organizers: - Google Doc - PDF Online Classroom Timer

ENGAGE

You work for a river rafting company and need to recommend clothing to wear while rafting. You will need good evidence and reasoning for why your customers should follow your recommendation.

Objective: Identify information about spandex and cotton and how they are made. **Make an initial claim.**

Slide 1

- Students should be introduced to the standard by reviewing this slide. [Cotton Vs. Spandex PowerPoint](#)

Slide 2

- Students will have a 2-3 minute class discussion about their river rafting experience.
- Teacher will show a short video showing people rafting. See “Teacher Tips” about choosing a local destination.
- Teacher and students will discuss the following as a class:
 - When river rafting, how do your clothing choices affect your comfort and safety, especially in colder weather and if you get wet?

Teacher Tips

Find a river rafting video of a local destination. Some options are provided in the “Other Resources” box of the materials section. If no local destinations exist, then use one of the others. Many people travel from different areas to the Snake River in Wyoming, so that is a good option.

If your students have not been rafting, you can ask them to think about a time they have done any



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- Teacher will then explain that students will look at two fabrics commonly used in outdoor clothing: cotton and spandex. Slide 3 - Students will read the prompt on slide 3. Ensure that they understand their role as employees and investigators. Slide 4-7 - Students can examine a few different cuts of cotton and spandex to make initial observations. Make sure to specify which fabric is cotton and which is spandex. (optional) - Students can then get into small groups and review a copy of the infographics: What is Spandex?, How is Spandex Made?, What is Cotton?, and How is Cotton made? - Students then use the information to complete the table on page one of the handout. - Once they are done with the table, students will make an initial claim about which fabric would be better to wear rafting on a cold day. - Instruct students that the claim will evolve throughout the class, and with more information, they can change their claim as they work through the lab.	water sports.
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EXPLORE

Guiding question: How are the macromolecules of cotton (natural) and spandex (synthetic) similar and different? Six stations will enable students to investigate each fabric and tie their observations to molecular structures. More and better evidence will help students to improve their argument.

Teacher- - Look at the infographic PowerPoint for instructions on how to set up the different stations. - Walk around and guide students at the stations and answer questions. Slide 8 - Students will view slide 8 - Students will be reminded that as employees of the river rafting company, they are responsible for the safety of their customers. - Students will rotate through different stations to investigate the properties of the two different fabrics so they can compare them. Using the evidence they gather, they will recommend which fabric would be best to wear to the customers. - There is no specific order for the stations. Students should rotate through each one as efficiently as	Teacher Tips - Set up the evaporating cooling station an hour before class so the thermometers can drop in temperature. The longer they are set up, the more significant the temperature difference. - If you have a larger class, you can have two or more of the same stations set up so students can rotate quickly. - Not all stations (i.e., the flame test) are directly pertinent to the river rafting phenomenon. The students can evaluate the information gathered and decide if it supports or refutes their claim. - The Chemical Composition Station may take a
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possible. Use an online or classroom timer. Each station should take less than 5 minutes. Students can move through the stations faster than that, but if any group gets stuck at a station for a longer time, they should move on when the timer goes off. Digital Timer Students will record their data, answer the questions for each station, and use this evidence to support their recommended claim about which fabric is best to wear while river rafting.	little more time. The teacher should make adjustments as necessary for their class.
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EXPLAIN

Consolidate and summarize information from the six stations. Help ensure students process the correct information needed to solidify their claim with good supporting evidence for their argument.

Slide 9

- Students will return to their original seats.
- Students will view slide 9 as an example of recommendations made using evidence, which should help them in their claim, evidence, and reasoning that they are completing in the “Evaluate” section.
- Students will complete the Explain portion of their worksheet.
- Talking with their groups, students will defend what they believe to be their molecular and macro-level evidence.

Teacher Tips

- Students engage in an argument based on evidence to defend their findings.

EVALUATE

Using the worksheet, students will write a final claim using their evidence gathered from the different stations as to which fabric to wear. Students will share their claim/argument with evidence and reasoning with another student. **Objective:** Write a final claim supported by evidence that will be shared with another student from a different group.

Slide 10

- Remind students that they work for a rafting company and need to argue which fabric would be better to wear.
- Students will complete the Evaluate portion of the worksheet.
- Students will share their findings with 2 other students not in their group.

Teacher Tips

- Walk around and make sure students are actually stating their evidence to justify their claim.



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ELABORATE

Students will create a travel brochure, infomercial, or web page using evidence in a customer-friendly way to present their claim/recommendation for what kind of fabric to wear while on their river rafting trip.

- Explain that the company has asked each student to present their findings using one of the following three ways:
 - **Travel Brochure:** It should include your claim/recommendation, all necessary evidence to support your recommendation, engaging pictures appropriate to the activity, and be neat and attractive.
 - Many platforms, such as Canva, Microsoft Publisher, or various Google or Microsoft documents, can be used to create this.
 - **Infomercial:** The video should be school-appropriate and engaging, and it should include the claim/recommendation and any necessary evidence.
 - A variety of platforms are available for this as well. Even a student's cell phone can be used to create a video. Others may include Screencastify or Quick Time Player.
 - **Google Sites web page:** Students will need to keep it school-appropriate. They must restrict it to only one page where the link will be added to the company's existing website. They should include engaging pictures appropriate to the activity, their claim/recommendation, and all necessary evidence to support it.
 - Students will use their claim, evidence, and reasoning on their student worksheets to help them gather the correct information.

Teacher Tips

- This activity probably won't be complete on day one of the lesson and could also be an extension.

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