Stations Setup Instructions

Stretch Station

Materials

- Infographic titled “Why is a swimsuit stretchy?”
- Several pieces of a shirt that is 100% cotton cut into 10 cm x 10 cm
- Several pieces of spandex cut into 10 cm x 10 cm
- Ruler

Procedure

1. Students should read the infographic before doing the activity.
2. One group member will take one piece of fabric (10 cm x 10 cm) and measure its length on the ruler.
3. While holding the fabric next to the ruler, the student will stretch it as far as it can go and measure the length they could stretch it to.
4. Subtract the stretched length of the fabric by the original length and record that number on the worksheet.
5. Repeat for the other fabric.
6. Students will then answer the questions in the worksheet under the stretch test.

Water Absorbency Station

Materials

- Infographic titled “Why do fabrics absorb different amounts of water?”
- Scale
- Bowl of water
- Weigh bowl
- Several pieces of cotton
- Several pieces of spandex

Procedure

1. Students should read the infographic before doing the activity.
2. After reading the infographic, students will grab a sheet of cotton and weigh the mass of the dry cotton.
3. Students will then put the piece of cotton in the bowl of water.
4. When the students take the cotton out of the water, they should let the fabric drip a bit but don’t wring out the cotton.
5. Next, put the wet cotton in the weigh bowl and record the weight.
6. Repeat steps 2-5 but with a piece of spandex fabric.
7. Students will then answer the questions in the Water Absorbency section of the worksheet.

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Evaporative Cooling Station

Materials

- Three Metal thermometer
- One wet piece of cotton
- One wet piece of spandex
- Fan (optional)

Procedure

- This station is set up before class by the teacher.
- Get a 10cm x 10cm cloth of cotton and get it wet
- Ring out excess water.
- Fold the cloth over the metal probe of the thermometer–do not wrap it.
- Make sure the cloth is in contact with the thermometer probe.
- Repeat this with another thermometer and a spandex cloth.
- Have a third thermometer reading room temperature.
- (Optional) Place all three in front of a fan and allow time for the temperatures to change.
- The temperature of the cotton should be lower than the spandex, which should be lower than room temperature. If the cloth is wrapped around the probe multiple times rather than folded over once, it tends to reach a point where it insulates the probe and will give invalid data for this investigation.

1. Students will read the paragraph at the top of the page titled “Evaporative Cooling” before the activity.
2. Students will then observe and record the temperatures of both the cotton and the spandex.
3. Students will then answer the questions under the Evaporative Cooling section on the worksheet.

Chemical Composition & Hydrogen Bonding Station

Materials

- Infographics titled “Compare and Contrast Chemical Composition.” (One for cotton and one for spandex)
- Infographic titled “Hydrogen Bonding”
- Cotton and Spandex models
- Water molecules (printed)

Procedure

- Print the cotton and spandex models. Cut out the strips and glue them end to end. Some middle strips can be left out if lab tables are not long enough.
- Print the water molecules on a transparency sheet or a different color of paper from the models.
- Tape the cotton and spandex models to the lab table.
- Have the water molecules in a bowl or beaker.
- Students should only have water molecules placed on the spandex model on the right side where the -NH groups are located. They should have water molecules along the entire length of the cotton model on the -OH groups.

1. Students will read through all infographics.
2. Students will place water molecules on the cotton and spandex models in places where hydrogen bonding could occur.
3. Students will find similarities and differences in the chemical compositions between the two fabrics.

Water Drop Station

Materials

- One large cloth of cotton
- One large cloth of spandex
- Bowl of water
- Pipettes
- Infographic titled “Water Drop”

Procedure

1. Students will fill a pipette with water from the bowl
2. They will put 2-3 drops of water on a dry spot of cotton and 2-3 drops of water on a dry spot of spandex.
   - It would be good not to use a super dark piece of spandex so students can observe what is happening.
3. Students will make observations about the spot of water on the cloth and answer the questions in the worksheet.
   - You may want to help students understand the difference between hydrophobic and hydrophilic at this station.

Burn Test Station

Materials

- Small pieces of spandex cloth
- Small pieces of cotton cloth
- Tweezers/ forceps
- Candle/burner
- Aluminum foil (to put underneath the burning fabrics)
- Infographic titled “Burn Test.”

Procedure

- Make sure you do this test in a well-ventilated area.

1. A teacher will light the burner/candle.
2. Students will put a small piece of spandex into the flame using tweezers.
3. Hold the burning fabric over the aluminum foil and observe how it burns, such as the smell, how quickly it burns, and the flame itself.
4. Repeat steps 2 and 3 with a small piece of cotton fabric.
5. Record your observations on both fabrics and answer the questions in the worksheet.

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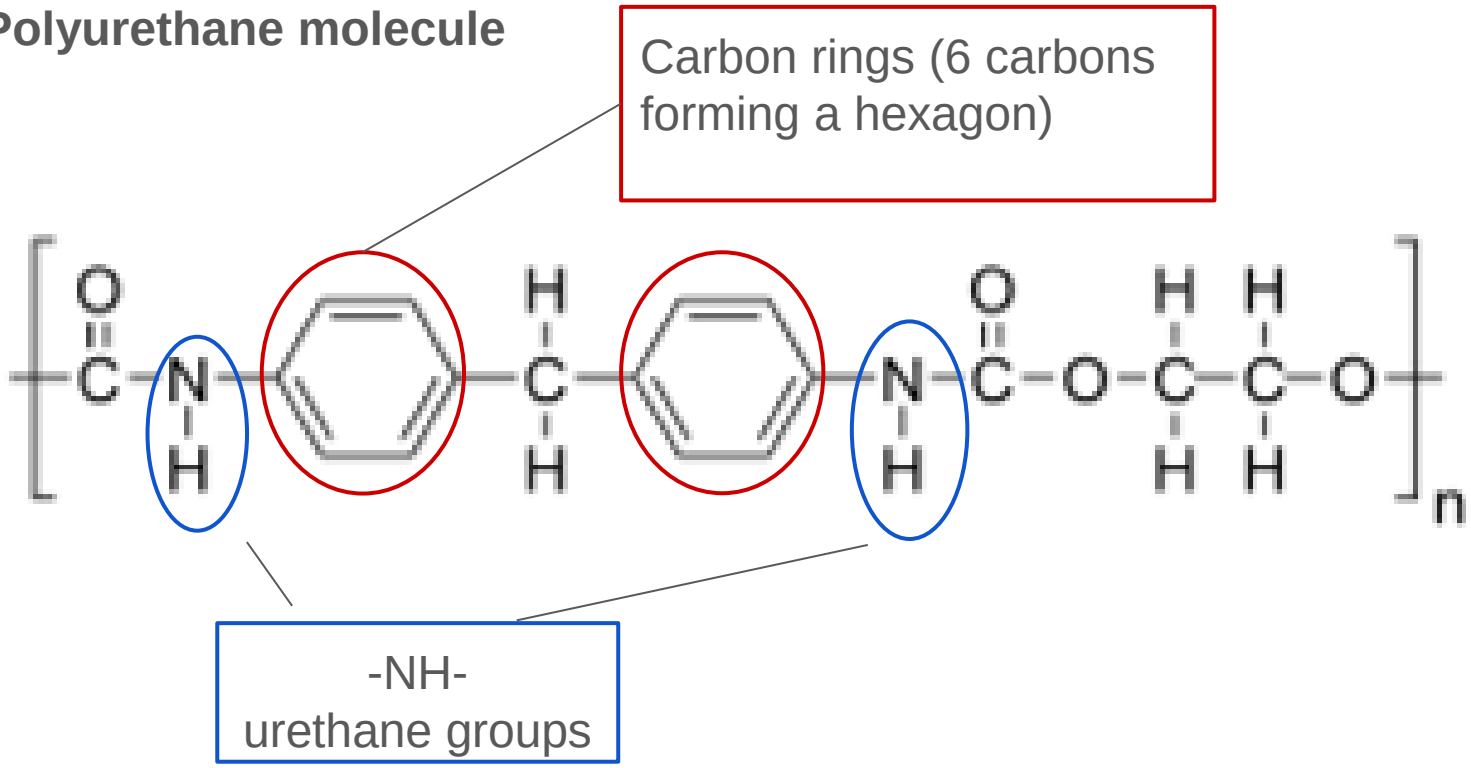
What is Spandex?

Spandex is man made. It is a synthetic product created from several chemical processes. The natural resource used to create most of spandex is fossil fuels retrieved from the ground.

Spandex is a synthetic polymer. It is made from fossil fuels. It is also called Elastane Fiber.

Chemically, it is 85% polyurethane molecules. These polymers are composed mostly of organic units of carbon rings joined by -NH-groups to link more together.

Polyurethane molecule



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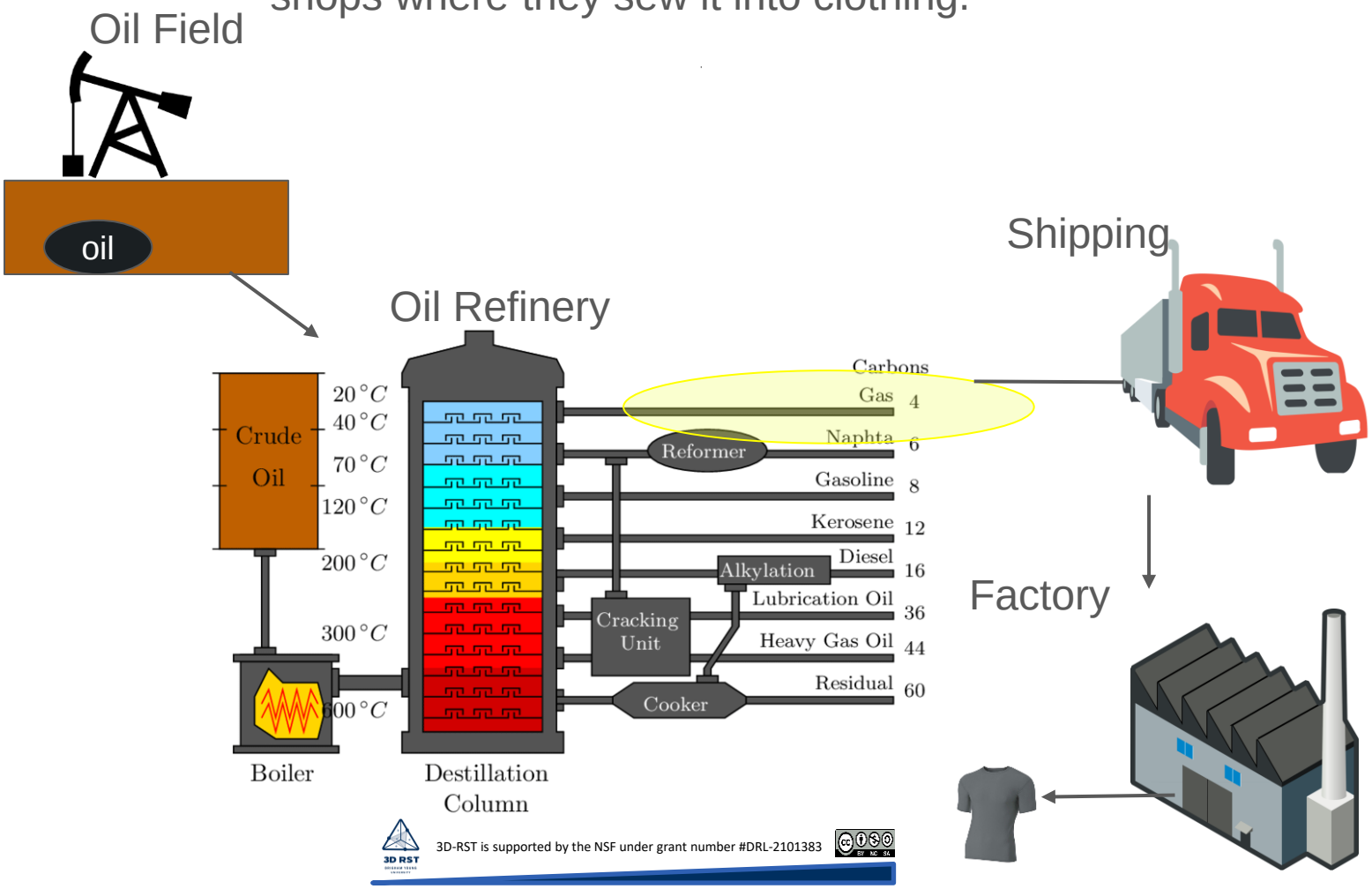
How is Spandex Made?

- Oil is pumped from the ground.
- Oil is pumped in pipes or transferred in trucks to an oil refinery.
- There it is separated by distillation into different grades or oil products.
- The top of the distillation is the gas products, this is where ethene (C_2H_4) is extracted.
- The ethene is then shipped to factories where it undergoes several chemical processes (production of polymers, several thinning, diluting, stretching and heating stages) then its bundled then the fibers are weaved together
- Once the fabric is weaved it is then shipped to fabric shops where they sew it into clothing.



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What is Cotton?

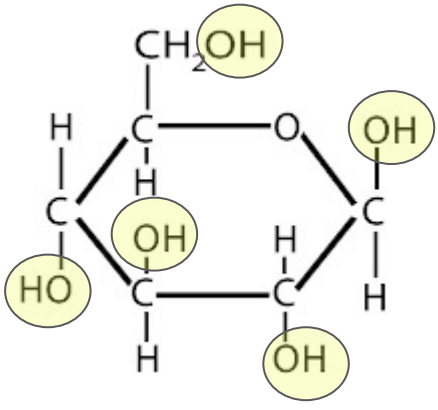
Cotton is a natural product. It is created by photosynthesis in cotton plants. The most common atom by mass in cotton is carbon and oxygen.

Carbon and oxygen came from carbon dioxide (CO_2) that originally was in the air but due to photosynthesis in the plant changed into carbon hexagon rings.

The cotton plant produces seeds that are protected by the cotton fibers. The cotton can be collected and woven into fabrics.

Carbon rings are very common in organic molecules. They usually all have carbon, oxygen and hydrogen in their ring shaped molecules. Cotton contains billions of these molecules linked in chains. The OH (Oxygen and Hydrogen) groups surround most the molecule.

Carbon hexagon ring



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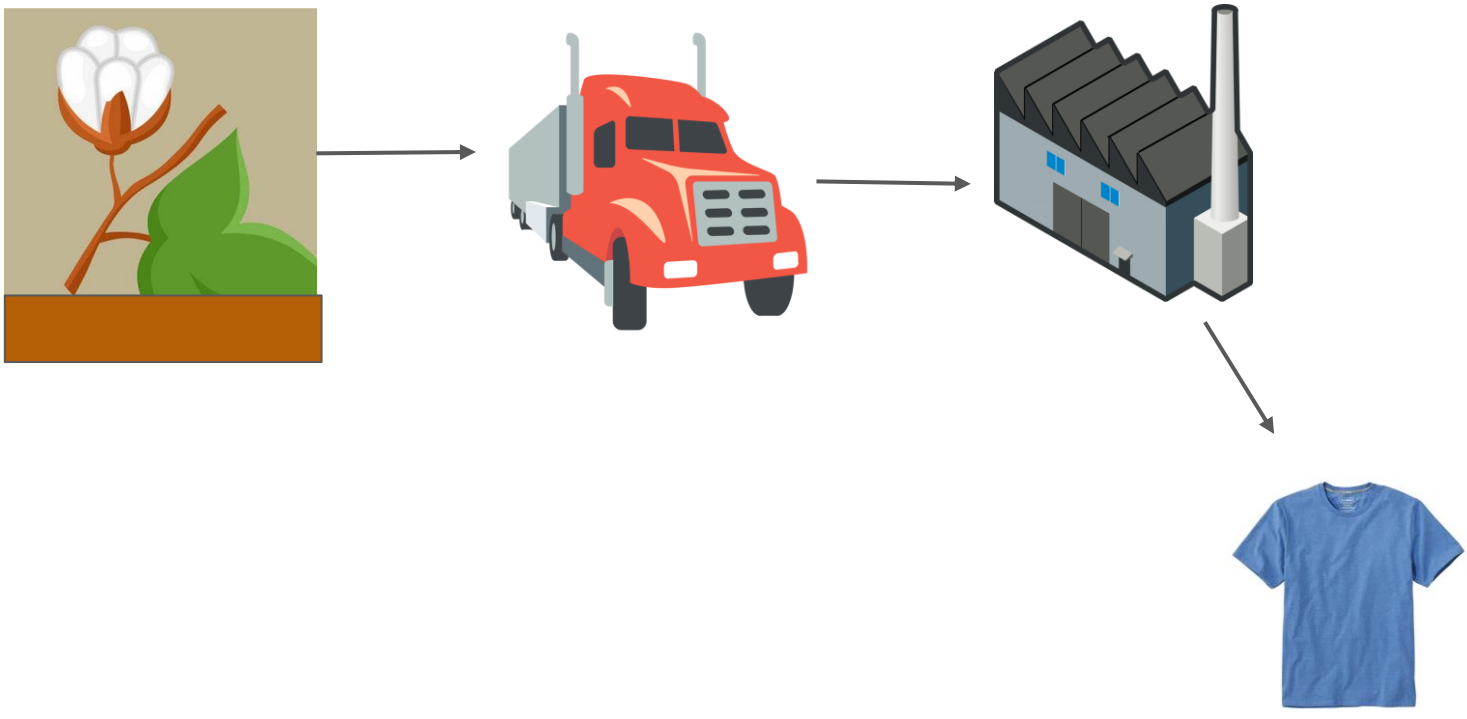
How is Cotton Made?

- Cotton is planted and grown in fields
- Once the cotton produces seeds it is picked either by machines or by hand.
- The cotton is then shipped to a tactile production facility.
- There it is carded, a process of forming long cotton fiber strands.
- It is spun into yarn.
- Usually it is dyed.
- It is then woven into different types of fabrics.
- Usually it is shipped to another facility where it is then cut and sewed into clothing.



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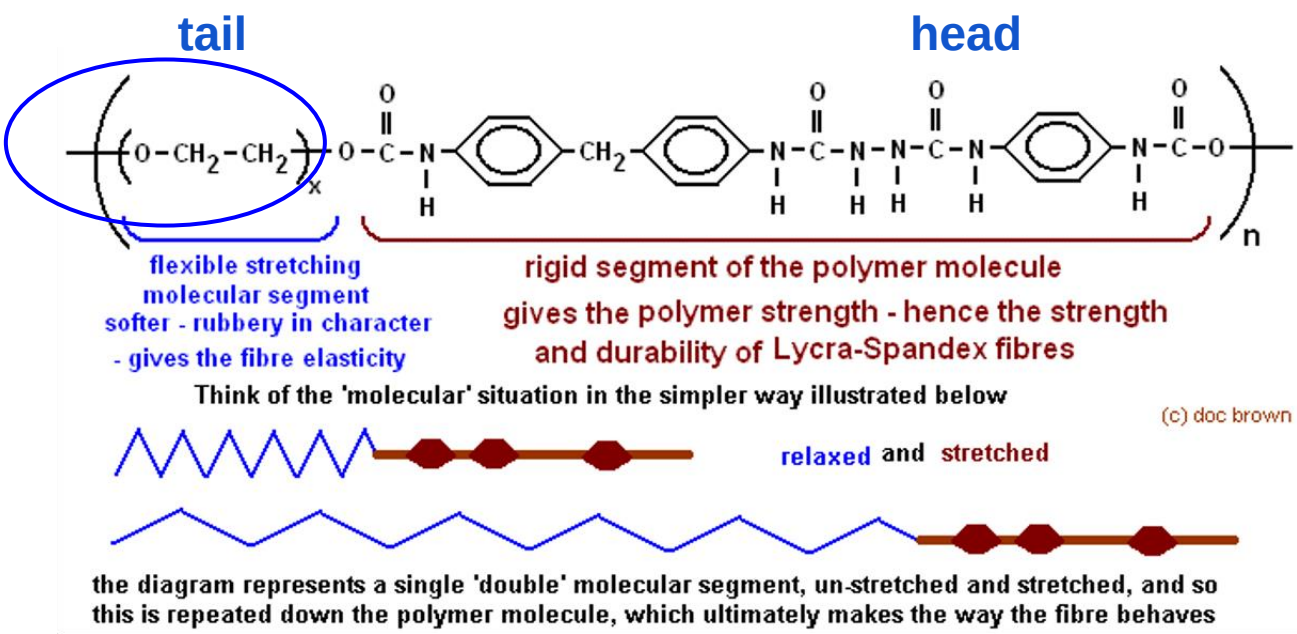
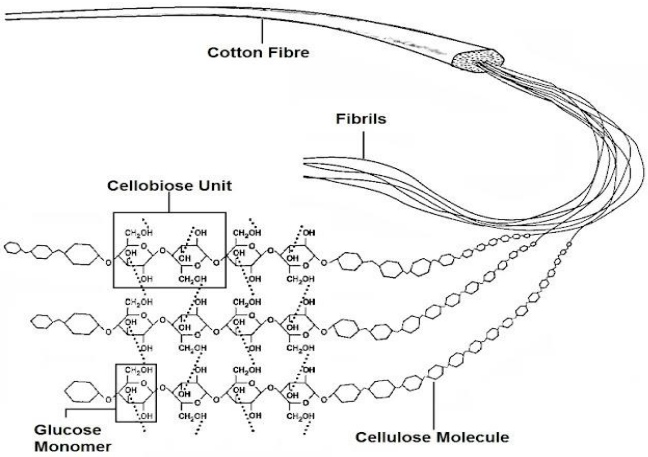
Why is a swimsuit stretchy?

Spandex fabric is made from long chains of plastic known as polyurethane. These chains are arranged in a way that allows the fabric to stretch and bounce back to its original shape. It's like a bunch of interconnected springs. The spandex macromolecule has two sides a **springy tail** and a **rigid head**.



Cotton is also composed of long chains of carbon rings but there are no sections that act as “springs.” Therefore, the fibers do not stretch.



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Stretch Test

1. Read the infographic about stretching.
2. Place each material at the zero end of the ruler (use the centimeter side- metric units!).
3. Pull the material as far as it will stretch.
4. Record the distance in centimeters that the material was able to stretch.

Record the distance stretched in centimeters (cm)

Distance stretched
\- Distance relaxed

Ex. 16.7 cm
- 10.4 cm
record 6.3 cm

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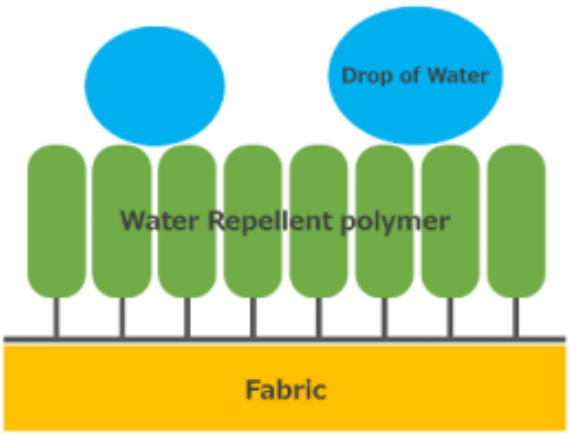
Why do fabrics absorb different amounts of water?

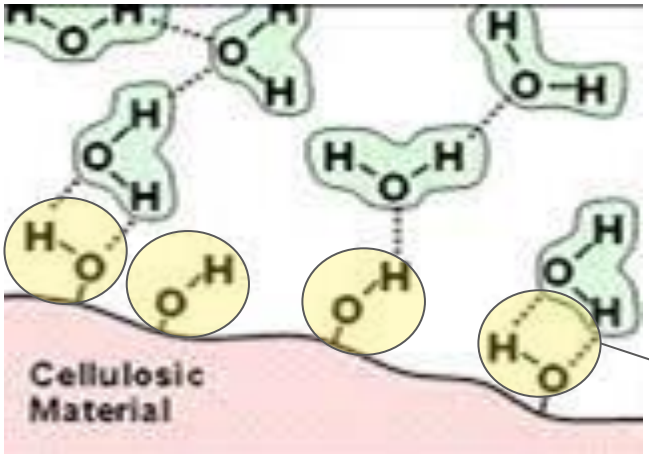
Spandex:

Spandex, also called lycra and elastane, is a type of polyurethane. It is **hydrophobic**, which means it repels water. Polyurethane is also used to make foam, coatings for decks and boats, and many other applications.



Cotton:

Cotton is pure cellulose, a naturally occurring polymer. Cellulose is a carbohydrate, and the molecule is a long chain of glucose (sugar) molecules. If you look at the structure of a cellulose molecule you can see the OH- groups that are on the outer edge. These negatively charged groups attract water molecules and make cellulose in the cotton absorb water well. Cotton can absorb about 25 times its weight in water. Chemists refer to substances like cotton as **hydrophilic**, which means that they attract water molecules.



OH- is attracted to the water molecules by electrons creating polarity and intermolecular forces hold the water to the cotton molecules.

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Water Absorbency Test

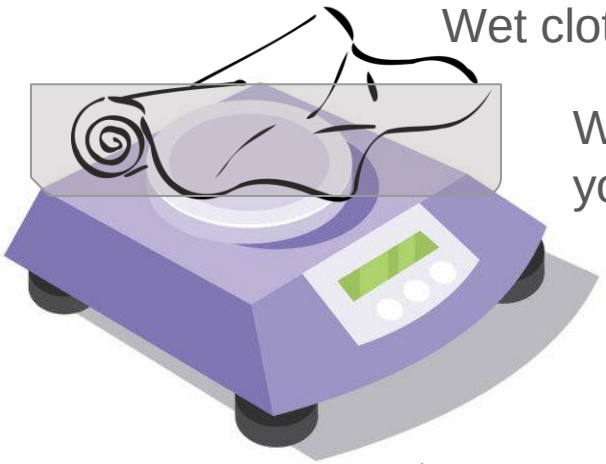
Water absorbency is a measure of how much water a given material can hold in relation to its mass.

Instructions:

1. Before beginning the experiment make sure the weigh boats are dry.
2. Measure the mass of the square of fabric and record.
3. Saturate the fabric with water. Let it drip several times before you take it to the weigh boats.
4. While the fabric is still wet, place it in the weigh boat. Record the mass of the water and the fabric.
5. Subtract the mass.
6. Next, divide the mass of the wet material by the mass of the dry material. Then multiple by 100 to get the percent change of mass in the fabric.

Example:

Material	Mass of Dry Material (grams)	Mass of Wet Material (grams)	Mass of Water (grams)	Percent Change (%)
X	2.4g	3.5g	1.1g	+146%



Wet cloth

Weigh boat - zero before you add the fabric

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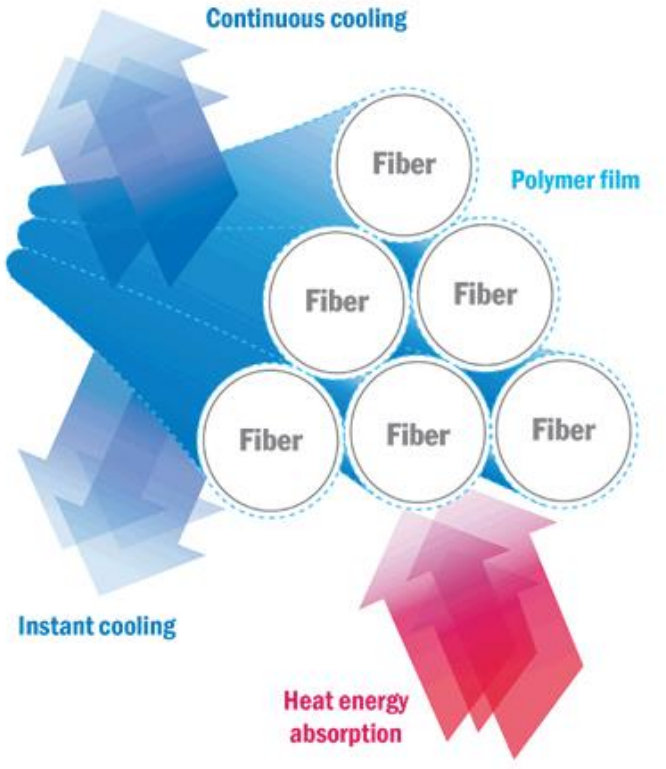
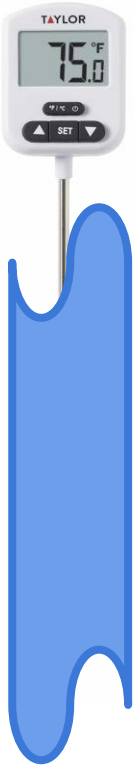
Evaporative Cooling Test

Evaporative cooling uses evaporation to help cool the air. Based on the principles of evaporation, hot and dry outside air is drawn through water-soaked cooling pads. As the air is pushed through these pads, the water evaporates and the heat in the air is absorbed, which lowers the air temperature.

Instructions:

1. Record the temperature in the room with the dry bulb thermometer.
2. Record the temperature with the spandex and cotton fabric wrapped around them.





Make sure the tip of the thermometer stays covered completely while you read the thermometer.

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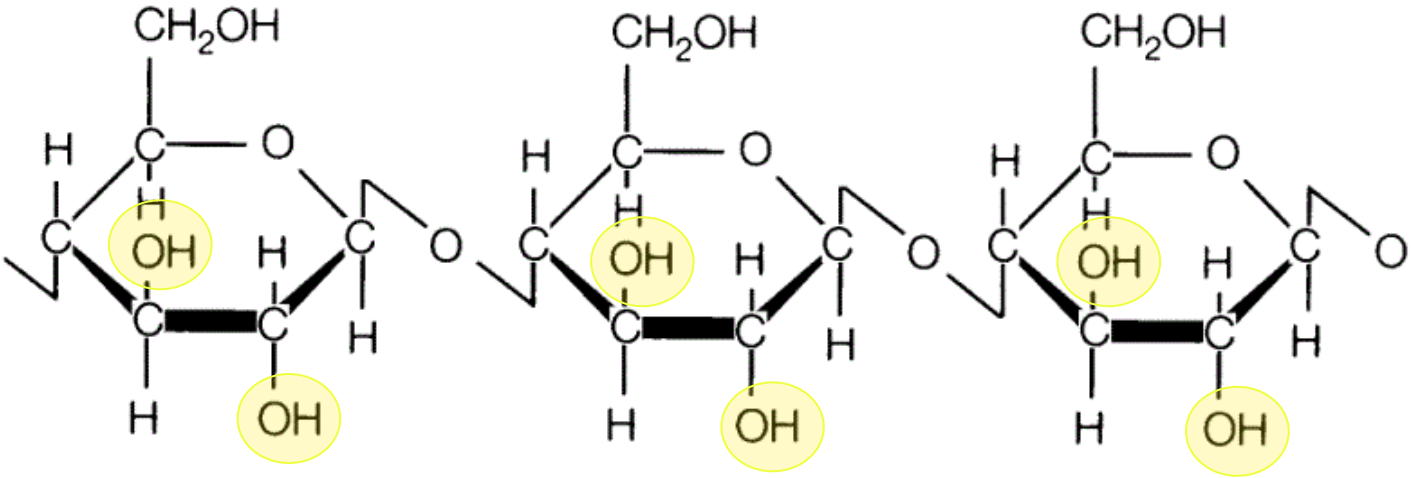
Compare and Contrast Chemical Composition



The chemical formula of cellulose is $(C_6H_{10}O_5)_n$

COTTON

Cotton, the **natural** fiber most widely used in apparel, grows around the seeds of cotton plants. It is made of cellulose material.Cellulose is a macromolecule — a polymer made up of a long chain of glucose molecules. **The oxygen-hydrogen (-hydroxyl or -OH) groups that line the edge of cotton's long cellulose molecule attract water, sucking it right up into its fibers**.

The chemical of cellulose is a single repeating pattern of the same carbon ring molecule. A single fiber is an elongated cell that is a flat, twisted, hollow, ribbon-like structure.

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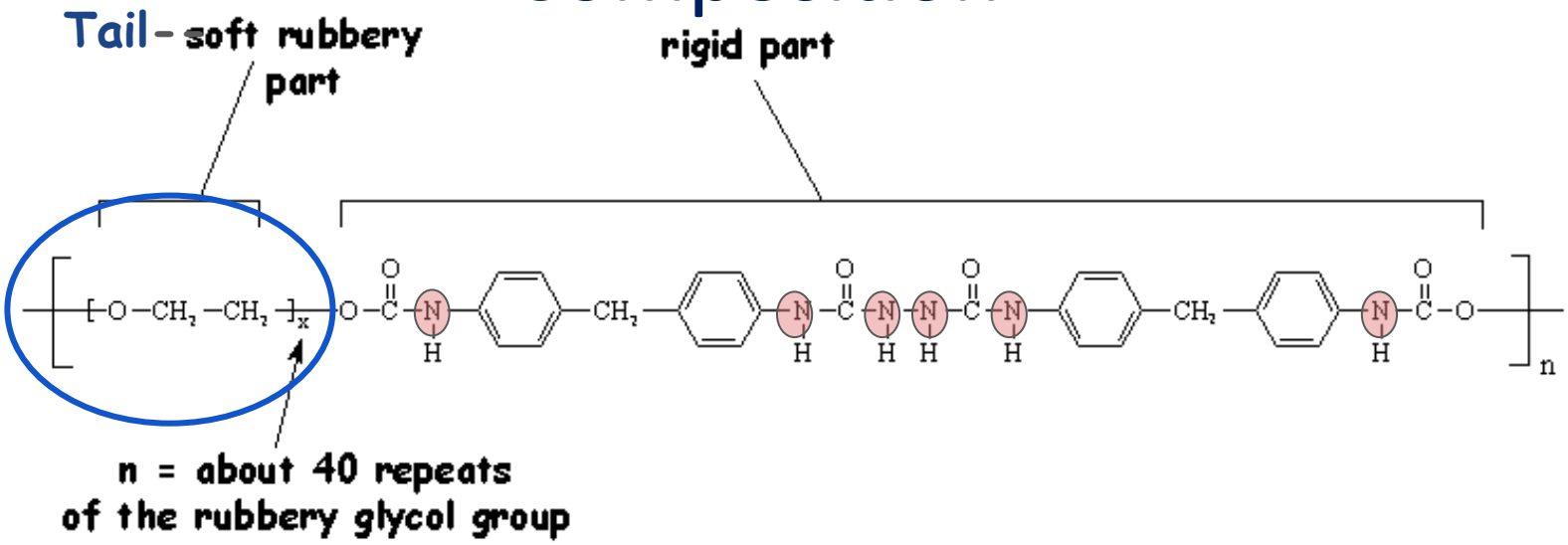
Compare and Contrast Chemical Composition



Chemical formula for spandex: $(CH_2CH_2O)_n(C_2OC(=O)C(C_4N=C=O)N=C=O)_n$

SPANDEX

The fiber forming substance used to produce spandex is any long-chain synthetic (**human-designed**) polymer composed of at least 85% of segmented polyurethane. Polyurethane comes from fossil fuels.

The basic elements of nitrogen, hydrogen, carbon and oxygen are synthesised with other substances to ethyl ester compounds in polymer chains of soft segments called the tail that provide stretch and harder segments that hold the chain together. **The N-H (amide) group slightly attracts water.**

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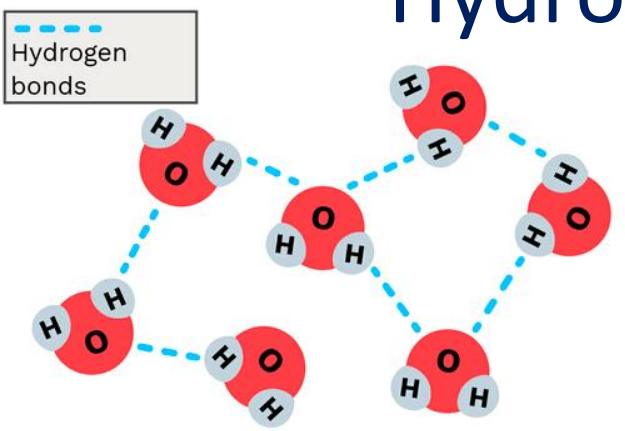
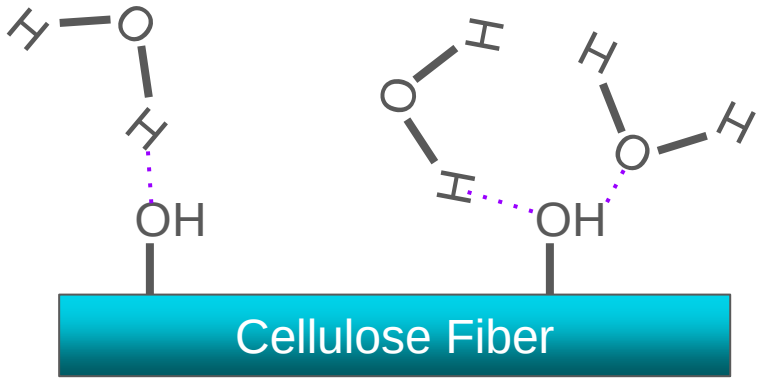
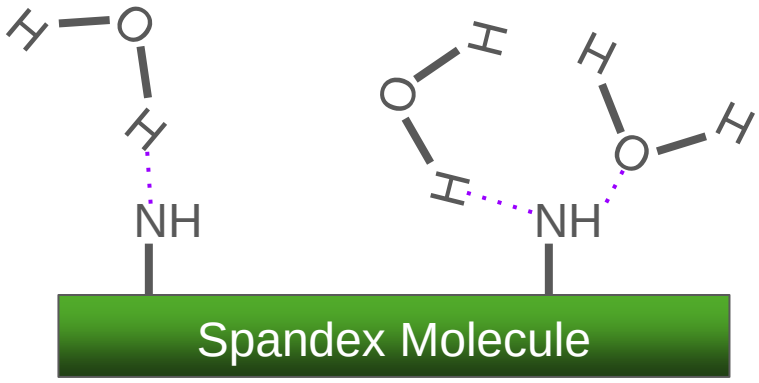
Hydrogen Bonding



Hydrogen bonds occur between molecules with N-H, O-H and H-F bonds. These are polar bonds. Water has a high number of hydrogen bonds between the individual water molecules.

Cellulose fibers have -OH groups that can interact with water and form hydrogen bonds. On average, each -OH group can make around two hydrogen bonds with water. C-H bonds are nonpolar.





Spandex has -NH groups that can also hydrogen bond. Hydrogen bonds with -NH groups are weaker than hydrogen bonds with -OH groups. Each -NH group can form an average of around 1.5 hydrogen bonds with water.

Instructions:

1. Find the -OH and -NH groups on the models of cellulose and spandex taped to the table.
2. Place water molecules by those groups to indicate hydrogen bonds could occur there.
3. Once all the water molecules are placed, count how many were put on each model.

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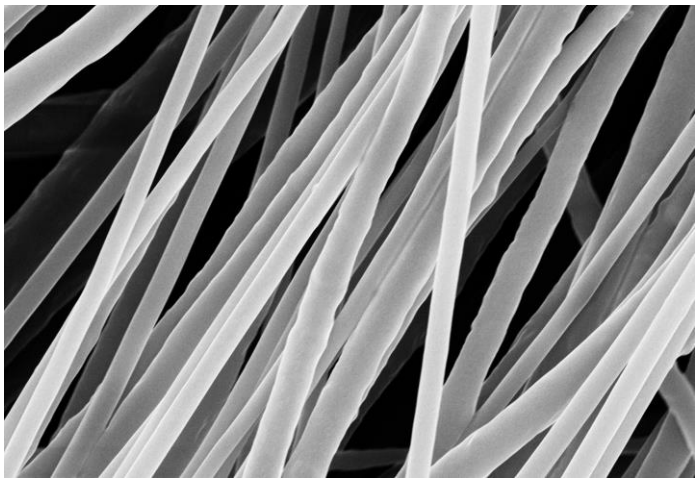
Water Drop Observations

Instructions:

1. Place a single drop of water on top of each fabric in a dry spot.
2. Make observations of what happens to the water as it is absorbed by the fabric.

Hydrophobic-water hating	Hydrophilic- water loving
-attractive force between water and macromolecule is weak. -absorption is slow	-attractive force between water and macromolecules is strong. -absorption is fast



Spandex - Electron Microscope

Cotton- Electron Microscope

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Burn Test

Chemical properties of different molecules can be observed with a flame test. Often to identify different fabrics burning a small amount can give clues to their molecular structures.

Instructions:

1. Light the candle.
2. Use the tweezers to move a small piece of fabric into the flame.
3. Once the fabric is burning, hold it over the aluminum to catch the charred remains.
4. Make observations and record.
5. Repeat with the other fabric.

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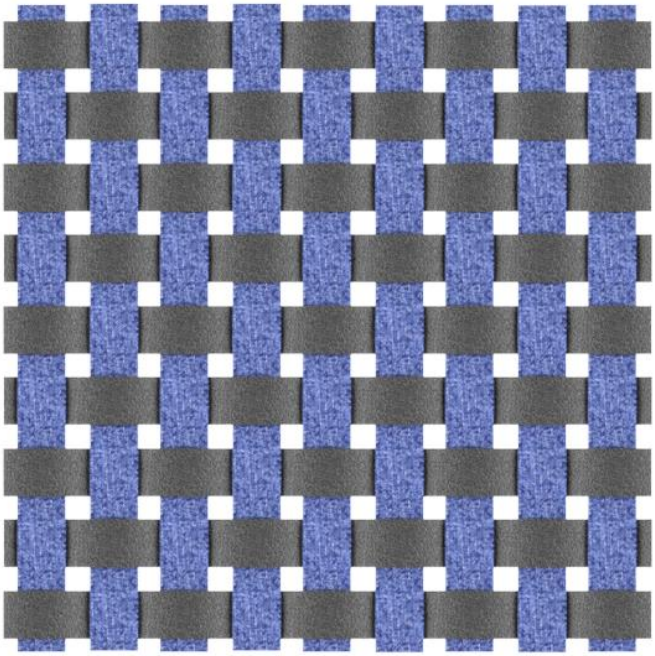
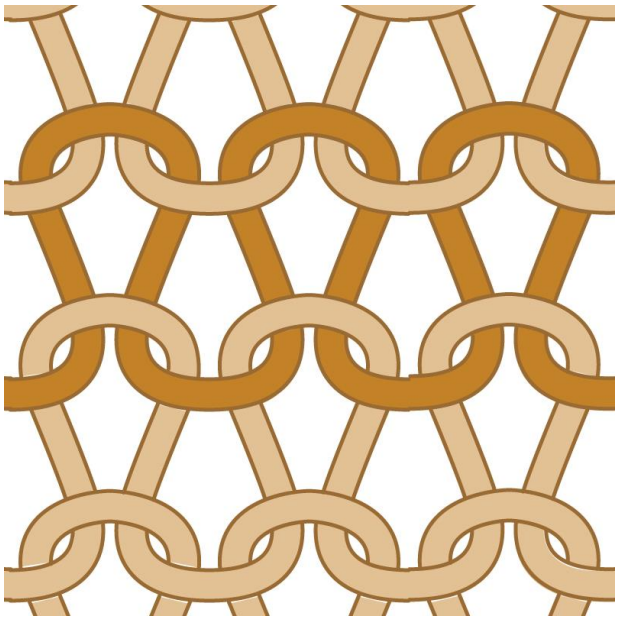
Fibers and Weaves



Woven Fabric



Knitted Fabric

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