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Polymers, Plastics, and Bioplastics

What's the big deal?

U.S. National Science Foundation

Engineering & Applied Science
UNIVERSITY OF COLORADO BOULDER

Take 5 minutes to fill out the first page in your booklet.

The big questions we will look at in this activity:

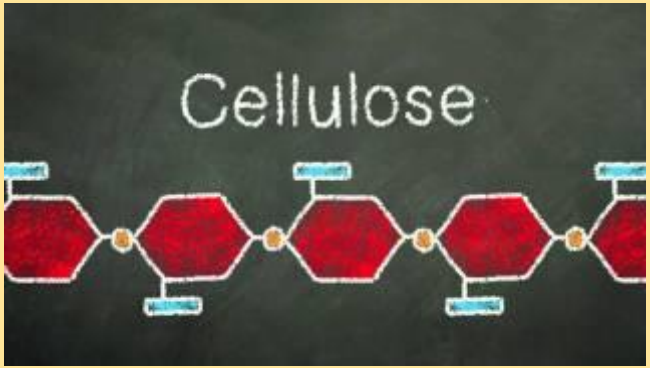
- **What are polymers, and why are they important?**
- **What is the difference between natural and synthetic polymers?**
- **Could bioplastic be a possible solution for some of our plastic usage?**

We are going to think like engineers and design a product that could help with the plastic usage problem!

Polymers - long chains of repeating building blocks

Synthetic

Natural



Natural Polymers

Plant cells have walls made from a polymer of glucose called cellulose.

DNA and RNA is a complex polymer. The sides are formed from chains of sugar, while the crosslinks are pairs of four monomers called nucleic acids.

Wool fiber is composed of keratin protein.

Protein polymer is found in muscles and other tissues and is made from polymers built out of monomers called amino acids.

Starch polymers are also formed from glucose chains.

		
cellulose	DNA	wool
		
protein	cheese	Starch

		
nylon	Teflon	polyester
		
silicon rubber	plastics	PVC

Synthetic Polymers

Synthetic materials are made from natural resources like petroleum.

Petroleum is a non-renewable resource.

Synthetic materials are made by chemically changing the starting substances to produce a material with different characteristics.

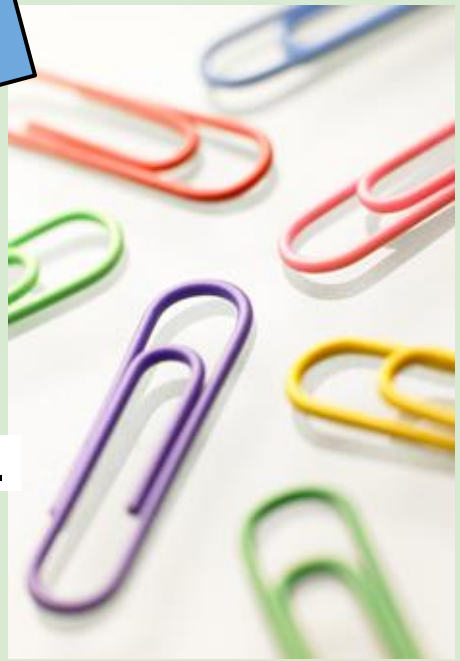
Most synthetic materials do not decompose easily.

Constructing Polymers Models

- Each group will receive 30 paper clips.
- You are constructing **polymers**.
- Polymers are made up of **monomers**.
- Each paper clip is considered a monomer.
- Begin building chains and answer the questions on your worksheet as you design.

Constructing Polymer Models

What did you learn?



1. Let's share some of your designs with the class and talk about what you did to change the shapes of your polymers. In what ways did the changes affect your polymer?
2. How does your polymer chain model real polymer behavior?
3. Why is it important for engineers to understand the shapes of polymers?

Next up: Bioplastics!

What if bioplastics could replace some of the plastics we use?

Bioplastic:

Environmentally friendly plastics that biodegrade and require less energy to make

Let's get to know our lab ingredients...

We will take today to talk about the lab ingredients and to take notes in your booklet.

Gelatin is a **protein polymer** made from collagen (found in animals). When gelatin is heated with water, it forms a gel that cools into a solid. It helps the bioplastic become **more stretchy and flexible**. Gelatin also **binds everything together**, making the bioplastic less likely to crack or break.

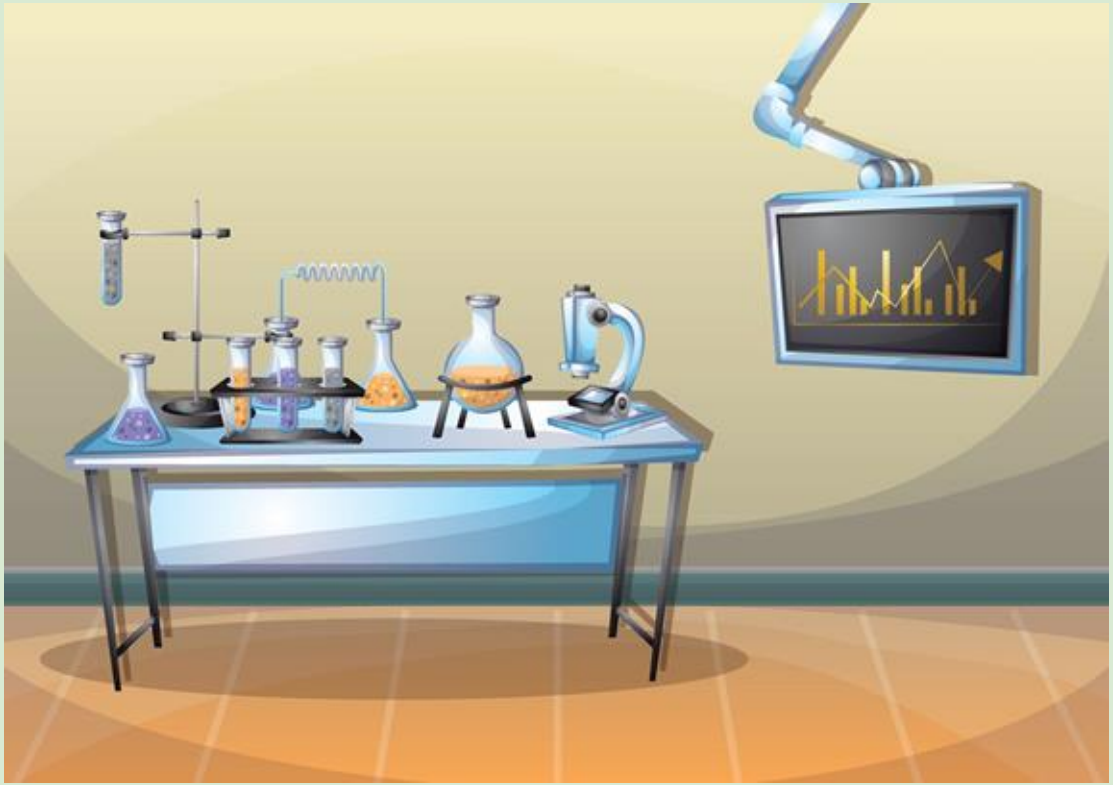
Cornstarch is made of natural polymers called **polysaccharides** (long chains of sugar molecules). When you heat cornstarch with water and an acid (like vinegar), the starch molecules open up and can link together, forming a **plastic-like material**. It helps the bioplastic become **flexible but firm** when it cools.

Glycerin comes from fats and oils found in plants and animals (like coconut oil, soybean oil). Glycerin makes the bioplastic **soft, bendy, and flexible.** Without glycerin, the bioplastic would turn out **hard, stiff, and brittle** (it might crack or break easily).

Glycerin sits between the polymer chains and helps them slide past each other a little bit, which creates **flexibility**.

Vinegar plays a very important role in the chemical reaction! The acid in vinegar **breaks some of the bonds** in the cornstarch during heating. This helps the polymer chains rearrange and link together better, creating a smoother, more flexible plastic.

Now, begin reading through your activity sheet and let's get started!



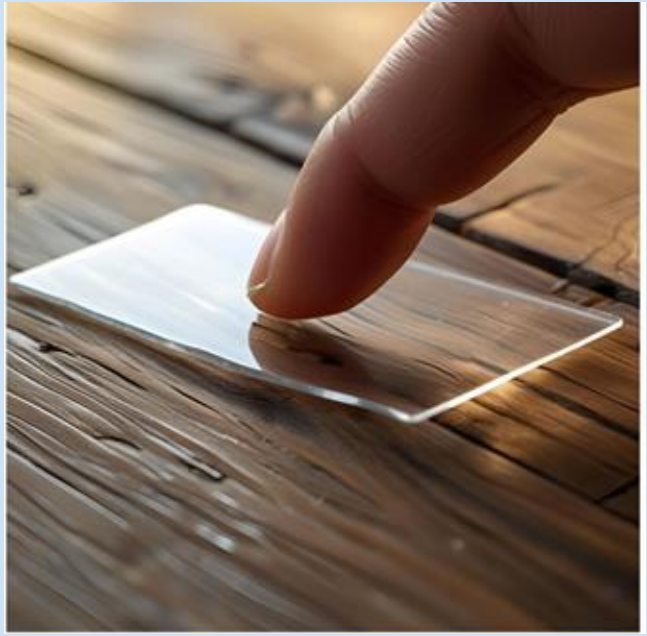
FLEXIBILITY TEST:

- Does it **bend easily**?
- Does it **spring back** to its shape (elastic)?
- Does it **crack or break** (brittle)?

RECORD YOUR RESULTS

in your booklet.

RIGIDITY TEST:

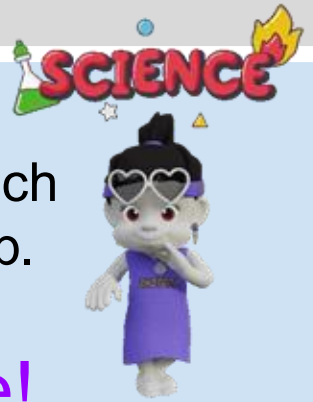


- Place your bioplastic piece on your table.
- Gently press down on the center.

RECORD YOUR RESULTS

in your booklet.

Today: Change a variable and rerun your lab!



Follow the instructions on Page 11. After you decide which variable you want to change in your recipe, rerun the lab.

DO NOT forget to change ONE variable!

You will run the activity exactly like you did before EXCEPT for the variable change.

Final Day of the Bioplastic Activity!

- Take 5 minutes to check on your second bioplastic piece and record the data you need:
  - Shrinkage
  - Flexibility
  - Rigidity
- Bioplastic Activity Wrap-Up– Individually answer the Bioplastic Activity Wrap-Up questions.
- When you finish, look back through your booklet and make sure you have everything filled out.

Quiz Time! - You may use your booklet.