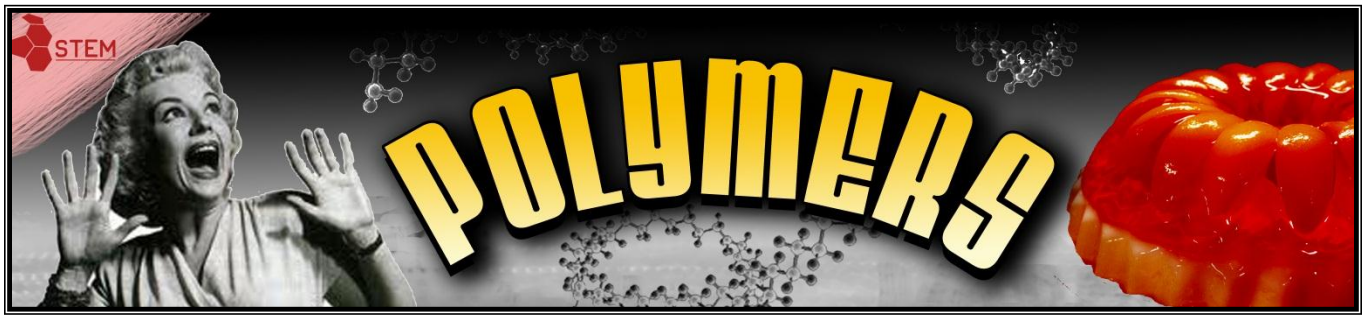

OBJECTIVE 1: **Students can list at least three examples of commonly used polymers.**	**ASSESSMENT:** **End of activity quiz, questioning toward end.**
OBJECTIVE 2: **Students can define polymers as chained atoms or molecules.**	**ASSESSMENT:** **Scavenger hunt and discussion.**

Academic Standards:

NGSS PS1.A (*Strand 8)* All different types of substances are made from some 100 different types of atoms, which combine with one another in various ways.

12.C.3b Model and describe the chemical and physical characteristics of matter (e.g., atoms, molecules, elements, compounds, mixtures).

Lesson Materials:

- **Latex Balloon**
- **Bamboo Skewer**
- **Paper Clips**
- **Slime kit**
- **Instant snow**
- **Diaper Gel**

Preparation:

- **Soak a skewer in oil.**
- **Blow up and tie a balloon.**
- **Prepare all containers of PVA and borax (one per student or one per group)**
- **Prepare all containers of paperclips. Container A should be three or more paperclips linked in a chain. Container B should be 8 paperclips linked in a figure eight. Container C should be single paper clips. Overall, each container should hold the same amount of paperclips.**
- **MOSAIC: Fill out and administer all MOSAIC forms to the lead volunteer and site contact.**

Procedure and Planning:

Introduction:

1. Discuss what characterizes a good observation. Good observations use an appropriate mixture of the five senses (or even a single one, depending on the situation), are objects or events that can be observed by more than one person, and pay close attention to detail. Good observations also do not form conclusions of how or why things work or interact.

Introduction (Cont.)

2. Have students practice their good observation skills with a balloon. Then ask them to make a prediction about what will happen when you poke a balloon with a skewer. Their observations should continue as the balloon is being skewered.
3. Balloon Stick the oiled skewer through the balloon.
4. Have students create a prediction/hypothesis as to why the balloon did not pop, reassuring them that they should be able to explain this by the end of the day.

HINTS: Fully inflate the balloon, then deflate it to approximately half of its maximum size. As the skewer enters and exits the balloon, aim for the darker parts (near the area where it's tied and its top). "Drill" the skewer by moving it between two fingers as you push it in.

Body of Lesson:

The next two portions of the lesson involved lettered and colored cups. Identification for the cups is as follows: Green sticker = Borax solution, Red = PVA, Blue = mixing cup; A = monomer (vinyl alcohol), B = polymers (PVA), C = cross-linked polymer (slime)

5. **Paper clips activity** - have students divide into groups and retrieve their materials. Each group should receive three paper clip cups (labeled A, B, and C) as well as one empty cup. Have students pour the paperclips from cup A into the empty cup, recording how easily the paperclips pour from one cup to the next. Students should then pour the contents back into cup A. Repeat with cups B and C. Have students answer the questions on the handout before asking what differences they noticed.
6. **Discussion:** Ask students what they think the individual paperclips represent. Lead students to the explanation that or, if necessary, explain that each of these is a molecule that we'll call a "mer." Explain that cup A is a cup of "mers," or as we call them, **monomers** as only sets of single "mer"s are present (and because "mono" means one. Think "monotone" - a person who speaks with one tone). You should then ask for a series of volunteers, having them demonstrate how easily mers are able to move around one another.
   a. Ask what they think the chain is - the answer? A CHAIN of "mers." Because "poly" means two or more of something, we call these "**polymers.**" Have students hold hands in two groups to make two chains and act out their movement. Is it easier or harder to move? (More difficult.) Does the formation look stronger or weaker? (Stronger.)
   b. Have students identify cup C as two polymer chains connected in the middle. They are actually connected by a different kind of molecule (not a monomer or polymer, in the case of slime). The polymers - or chains - act like the sides of ladders, while something else cross-links them - that is, link them across. Students can again act out **cross-linked polymers** in class by making the formation and moving around, then reflecting on their observations.
   c. Discuss with students how they matched up the shapes and letters and why they matched them up the way they did. Walk through the process of making slime, demonstrating it to the room. As you hold up the PVA, name it as "***poly***vinyl alcohol." Ask students whether they now believe this to be a monomer, polymer, or cross-linked polymer. Explain that PVA is a polymer, made from vinyl alcohol, which is a what? A monomer!
   d. Name the next object as borax - neither a polymer or a monomer, but something else. Ask students questions about what they think will happen when the two mix. Have them mix the two chemicals. So what's the answer? They form a cross-linked polymer - slime! The borax connects the two polymers like the rungs of a ladder.
7. **Real World Examples:** Have students come up with one or two examples of what they may think might be polymers. A few examples include gum, plastics, Jello, and rubber bands.

Closure:

8. **Review:** Using what we've learned, review how the balloon worked. The balloon works because it is made of polymers - a number of chained monomers. The skewer "slips past" the chains without breaking them. This holds the balloon together and provides its structure. Oil is used because this sometimes opens gaps, which the oil fills. Lead students to this answer through a series of questions, reviewing the material as you do so. Some questions may include "what does poly mean?"; "how are these multiple 'mers' or monomers hook together in a polymer?" (in a chain); " So why wouldn't the skewer pop it? (it slips in between chains). Use examples/props if necessary.

The Balloon Observation

Write your observations about what happens when the skewer pierces the balloon:

Why do you think this happens? Write your hypothesis here:

Paperclips - record your observations of the paperclips as you pour them from their cup in to the empty cup and back.

Cup A Observations	
Cup B Observations	
Cup C Observations	

Be sure that you are wearing your eyeglasses. Do not eat or drink any chemicals, and wash your hands when you are finished working with any chemicals.

Chemicals - You have three cups: a red cup, a green cup, and an empty blue cup.

1. Pour your vial of colored liquid into an empty cup and back into the vial (like you did with the paper clips), recording your observations about the liquid AND how it moves.

Observations:

This colored liquid is most like the paper clips in cup A B C because...

Pour the liquid back into its original container (the plastic vial) and add the clear liquid. The clear liquid is NOT A MONOMER, POLYMYER, OR CROSS-LINKED polymer. It is something completely different. Place the lid on the container and shake it. Write down your observations of this new substance AND how it acts as you pour it from cup to cup.

Observations:

This red cup liquid is most like the paper clips in cup A B C because...

List of Plastics:

Human Polymer Demo:

One person represents a _____.

Several people linked together represents a _____.

How does a bond affect the nature of a polymer?

Paperclips - record your observations of the paperclips as you pour them from their cup in to the empty cup and back.

Cup A Observations	
Cup B Observations	
Cup C Observations	

Polymer Exploration

Balloon:

- What type of polymer is it?
- What type of bonds does it have, strong or weak?
- How is a skewer able to go through the balloon?

Sodium Polyacrylate:

- What type of polymer is it?
- What type of bonds does it have, strong or weak?
- What other applications could this polymer have?

Polyvinyl Alcohol:

- **What type of polymer is it?**

- **What happens when the borax is added? What type of polymer is it now?**