Connect with Slime

Facilitator Led Tabletop Activity

When shown how to make *slime* that clearly is not right, children determine that something must be added to fix it. Should they add a chemical connector or a bond breaker? Models help children make the right choice.

Question to investigate

Should you choose a chemical connector or bond breaker to make good slime?

Chemistry concepts

- Good slime starts with PVA which is a polymer. This means that it is made of long skinny molecules that each are made up of many repeating units.
- To design a good piece of slime you need to use the right kind and amount of a chemical connector.

Activity logistics

- **Ages**: While this activity is best-suited for upper elementary and middle school students, children as young as 5 can make slime with assistance.
- **Group Size**: This activity serves up to 48 children over a period of 2 hours, with each iteration of the activity lasting approximately 8 minutes.
- **Set-up**: Arrange the materials along one side of an 8-foot table into four stations to reach up to four children at once. Place the molecular models near each facilitator.
- **Facilitators**: Two facilitators will be needed at each table to manage 2 stations each.

Prepare in advance

What you'll need

- 2 bottles polyvinyl alcohol solution, 4%, 32-oz or 1 liter size
- 2 bottles sodium borate solution, 4%, 8-oz or 250 mL size
- 2 bottles of citric acid, 8-oz or 250 mL size
- 4 bottles of watercolor gel paint, such as Colorations® brand, or color solutions used by soap makers
- 50 small plastic beakers, 90 mL size
- 4 stirring rods
- 4 jumbo pipets, 8 mL volume
- 2 medicine cups
- 48 small containers with lids, 2-oz, 60 mL size
- 36 Mardi Gras bead necklaces of the same color
- 3 Mardi Gras bead necklaces of another color
- 6 clear plastic cups
- 1 permanent marker
- Scissors
- Foodservice or nitrile gloves for all
  - Extra small and small for children
  - Medium and large for teens and most adults
- Paper towels for spills
- 2 containers of hand wipes

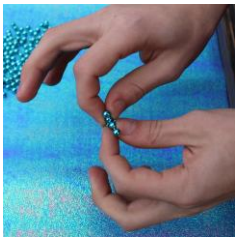
Notes about the materials

- This activity uses polyvinyl alcohol. Polyvinyl acetate is in the white glue and clear glue used in many slime recipes. Their structure and function in slime are similar.
- Jumbo pipets are recommended for this activity because one draw of the solution, is about 5 mL. This makes dispensing the "chemical connector" easier for the presenter.
- Offering only one color makes facilitation easier and results in better slime. This is because participants have a tendency to want to mix colors. This takes up valuable time and inevitably results in more than 10 mL of paint being added to the PVA solution. Too much paint causes slime to be gooey, sticky, and difficult to handle.

Safety information

- Wear splash goggles and either foodservice or nitrile gloves when making slime.
- Safety information, as shown on page 9, must accompany each piece of slime participants take with them.
- Wearing disposable gloves when playing with slime at home limits exposure and prevents skin irritation such as a rash or rare, yet severe, chemical burns.
- Wash hands before and after playing with slime
- Store slime in a small plastic container with the lid snapped in place.
- Keep slime away from food and out of reach of young children and pets.
- If slime gets in the rug, on furniture, or on clothing either wash with warm soapy water immediately. Alternatively, allow it to dry completely and then rub the area with a clean rag until it flakes off.

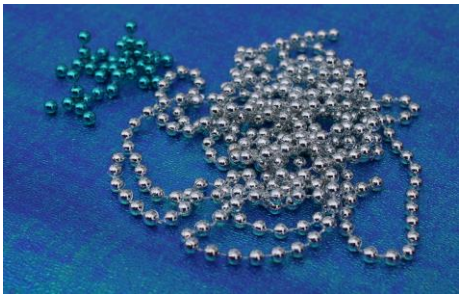
Prepare the activity




Make molecular models

1. Look for a section of a Mardi Gras necklace where it appears that two beads were glued together. Use scissors to cut those two beads out leaving a very long strand of beads. Do this to a total of 12 Mardi Gras bead necklaces. Each cut necklace will represent either the polymer chains or the tetraborate ions.
2. Use a permanent marker to label two sets of three clear plastic cups PV*A*, B*B*, and C*C*.
3. Place six polymer chains in each of the six labeled clear plastic cups.
4. Cut 3 Mardi Gras bead necklaces into 4-bead lengths. You should be able to make 20 or more small pieces per necklace.
5. Hold two 4-bead lengths together like the letter x. Then twist together twice. These will represent the tetraborate ions (a.k.a. chemical connectors).

6. Do the following to each of the cups:
    a. Do nothing to the six polymer chains in cup PVA.
    b. Cut the polymer chains in cup BB into shorter lengths. Place a pair of scissors in the cup to indicate "Bond breaker."
    c. Use 5 tetraborate pieces to randomly connect sections of three of the polymer chains in cup CC together. Secure the connections with a twist.
    d. Use 10 tetraborate pieces to randomly connect sections of the remaining three polymer chains together. Secure the connections with a twist.



Change labels on bottles

1. Label the borax solution, *Chemical Connector*. Label a similar-looking bottle, containing citric acid, *Bond Breaker*.

[Note: *Bond Breaker* will not result in slime when mixed with PVA solution. It is a prop that you could fill with water or vinegar.]

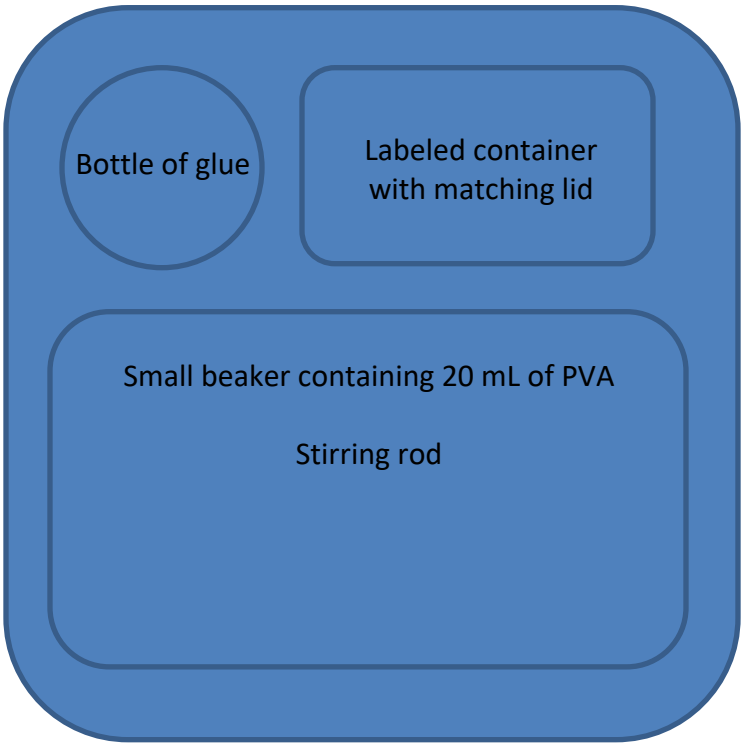
Prepare on-site

Pour PVA solution

- Pour 20 mL of PVA solution into as many small beakers or cups as possible.
- Label containers to take slime home by affixing the "slime" label to the side of each container.

Group materials on your table

- Place 4 trays across the front of an 8-foot table to make four stations.
- Arrange items on the tray, as shown.
- Arrange the bottles of chemical connector and bond breaker, along with two droppers, near each facilitator.
- Place each set of three cups, labeled PVA, BB, and CC, near each facilitator.



Facilitate the activity

Invite participation

1. **Have children tell you about their experience making slime.**
   Would you like to make slime that you can take home with you?
   - Have you made slime before? *Yes!*
   - What are some characteristics of good slime? *It's thick and stretchy.*
   - What kinds of slime have you made before?

2. **Introduce the problem—runny slime!**
   I hope you can help me with a problem. I mixed together PVA solution with glitter paint and no matter how much I stir or shake, it just will not thicken up to be the slow-flow, stretchy, terrific slime you told me about. *[Show children your runny slime in a small container with the lid snapped on securely. Shake and move the container to show that the liquid inside is runny and will not thicken.]*

- You have made slime before, what do you think went wrong?
  You need to add another ingredient that will make the slime thicker.
  You need borax or contact lens solution or liquid starch.

3. **Establish that we need to use science to solve the problem.**
   You are right we need to add something! I do not have the solutions you told me about, but I do have two solutions. One is a *bond breaker* and the other is a *chemical connector*.
   - Which one should we use to make this runny mess become thick and stretchy?
     Not sure or just a guess.
   - Why did you make that choice? *Unsure*.

   Hunches and guesses are not good enough for science. Let's use chemistry to figure out whether Bond Breaker or Chemical Connector will fix this mess!

Deepen Understanding

4. **Take a closer look at the ingredients already mixed together in the cup**.
   Chemists use models of molecules to help them make predictions about what will happen when substances are mixed together.
   - Cup PVA represents the bottle of PVA solution.
   - Cup BB shows what happens to PVA when Bond Breaker is added.
   - Cup CC shows what happens to PVA when Chemical Connector is added.

   Cup PVA—Model for PVA polymer
   [Give each child one string of beads to hold and move in their hands. Take the third polymer to show them how to move it back and forth from one hand to another to test how it flows.]
   - This is a model of the molecule that makes polyvinyl alcohol or PVA for short. What do you notice about this molecule? *It's long and skinny, has many beads that look the same on it and is flexible.*
   - These are important things to notice about PVA. This long molecule is called a *polymer* and like other polymers, it has a long skinny shape, has many parts on it that are made of the same kinds of atoms, and it's flexible.
   - The purpose of glitter paint is to make slime look interesting. You can make perfectly good slime without it, so for our model, we are going to skip it.
   - Place your polymers back in Cup A. You can see that there are polymer chains in the other cups. You need PVA to make slime. If you ever used glue to make slime, you used PVA, because it is an ingredient in many kinds of glue.

5. **Use models to consider the molecular structure of the chemicals needed to make slime.**
   You said that we need to add something that will make the slime thicker.
   Let's use models to see what Bond Breaker and Chemical Connector do to PVA.

   Cup BB—Model for Bond Breaker mixed with PVA polymer
   [Remove the scissors and pour the contents of the cup into your hand. Try to drop the contents of one hand into the other as though you are trying to show how slime can stretch and flow.]
   The scissors represent Bond Breaker.
   - What do you think Bond Breaker does when mixed with PVA?
     It cuts PVA into shorter pieces.
   - Will this make thick and stretchy slime? *No or probably not.*
   - Why do you think this? *It doesn't hold together.*

   Cup CC—Model for Chemical Connector mixed with PVA polymer
   [*Pick up one set of beads and pull and stretch as you would with a large piece of slime*.]

   The small clusters of beads represent Chemical Connector.
   - What do you think Chemical Connector does when mixed with PVA? *It connects PVA together in different areas.*
   - Will this make thick and stretchy slime? *Yes, maybe.*
   - Why do you think this?
     It holds together. It moves flows and stretches a little.
   - What do you think will be better to add to PVA—Bond Breaker? Or Chemical Connector? *Chemical Connector!*

   [*Pick up the other set of beads and pull and stretch as you would with a large piece of slime*.]
   - These connected PVA polymers seem a little different. What differences do you notice?
     One has more chemical connections. The one with fewer connections feels looser. It flows and stretches more. The one with more chemical connections feels tighter. It doesn't flow or stretch as much.
   - Which do you prefer?
     The one with fewer/more connections.
     The amount of Chemical Connector we add changes the properties of slime.

Support Exploration

6. **Make slime!**

[Give each child a pair of properly-fitting gloves and splash goggles. Enlist the help of the adults in putting gloves and goggles on their children. Adjustments may need to be made to the goggles. Put on your own goggles and gloves.]

- Start with 20 mL of PVA solution in a small plastic beaker.
- Squeeze 10 mL of glitter paint into the PVA solution.
- Use a stirring rod to mix the glitter paint and PVA solution together really well.
- Do you want me to add the *chemical connector* or *bond breaker* to your PVA? Why do you want that?

[Open the bottle of Chemical Connector and use a dropper to slowly add 5 mL of this solution as each child stirs constantly.]

- Keep stirring as I add the chemical connector. Imagine what your slime would be like if the chemical connectors were all in one area. It's better if they are mixed throughout your slime. So, keep mixing.
- Pull your stick up out of the beaker. Now, this looks like it has the wonderful properties of slime you told me about!
- Put your slime into a container, put the lid on, and take your slime with you.
- Throw your dirty gloves away. You may choose to use gloves when you play with slime at home. No matter what, be sure to wash your hands thoroughly after making or playing slime.

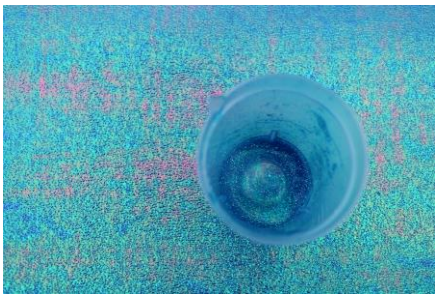
[Give each student a hand-wipe for now and instruct them to wash their hands with soap and water after completing all of the hands-on activities offered in this space.]

Clean-up

Reset for the next group

- Stack the used beakers and push them aside for cleaning after the event.
- Wipe the stirring rods with a paper towel and return them to the tray.
- Position a clean beaker containing 20 mL of PVA solution and a container with its lid on the tray.

At the end of the event



- Place the dirty beakers in a plastic bag for cleaning later. They come clean easily after the slime has dried. So, once the beakers make it to their destination, if they are not already dry, set them out to air-dry overnight. Once dry, the thin layer of slime inside the beaker flakes off easily. Wash the beakers in warm soapy water, rinse with water, and then allow them to air dry.
- Rinse the medicine cups used to hold the chemical connector (a.k.a. borax or sodium tetraborate) solution. Dry with a paper towel.
- Tighten the caps on the glitter glue, chemical connector, and PVA solution.
- Used pipets and leftover slime can be disposed of with regular solid trash.
- Pack everything else back in the large bin to return to ACS.

Frequently asked questions

Can you make slime without borax?
You can make slime without using the powder sold under the brand name *Borax*. However the chemical, sodium borate, which is sold to consumers as *Borax*, is an ingredient in many items such as contact lens solution, liquid laundry starch, and laundry detergent. If these items are used to make slime, the resulting slime will contain sodium borate.

How can I minimize the risks associated with using sodium borate?
Limit your exposure to sodium borate as a powder. Use it in solution (for example in contact lens solution or liquid starch). Limit the time your skin touches slime that contains sodium borate by wearing gloves every time you make and play with slime. And always wash your hands after making or playing with slime.

Do I have to wear gloves every time I play with slime? I never did that before!
If you know that you do not experience a rash or bad reaction when making or playing with slime, you may choose to use your bare hands. Be sure to wash your hands after making or playing with slime. In fact, it's a good idea to wash your hands before playing with slime, too. This will prevent bacteria from getting in and growing in your slime.

Note: Anytime a chemistry item is sent home with participants, it should be accompanied by safety information. The text below is an example of what you might include on this card.

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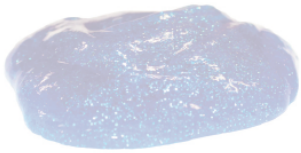

How is this type of slime made?

This type of slime is made by combining two solutions—each with a key ingredient. One solution contains Borax, more specifically sodium and borate ions, dissolved in water. The other contains long chain-like molecules called polyvinyl alcohol (PVA) dissolved in water. As the solutions mix, the borate ions react with the PVA molecules and form connections between them. The resulting interconnected structure holds water molecules and gives slime its squishy slow-flow consistency.

What safety precautions must be taken with slime?

Keep slime away from very young children, pets, fabrics, carpets, furniture, and areas where food is prepared or consumed.
If known skin sensitivities exist, wear protective nitrile gloves when handling slime. Sodium borate can cause skin irritation and rashes in sensitive individuals. This is rare. However, if rash or irritation occurs, rinse skin with plenty of water and avoid skin contact with slime.
Always wash hands after playing with slime.
Dispose of slime with the household trash, especially if it develops noticeable signs of mold or bacteria such as spots, fuzz, a foul smell, or a release of liquid.

acs.org/kids

Do more with slime and try other experiments!

acs.org/kidsandchemistry

Find out more about the science of slime and get tips for sharing science with kids.

What is in this slime?

This slime is more than 96% water! The water comes from the Borax and PVA solutions. Once combined, PVA makes up nearly 2% of the mass of the resulting slime. Borax makes up less than 0.5% of the slime. Wash able glitter paint and a preservative, to prevent the growth of mold and bacteria, are also in this slime.