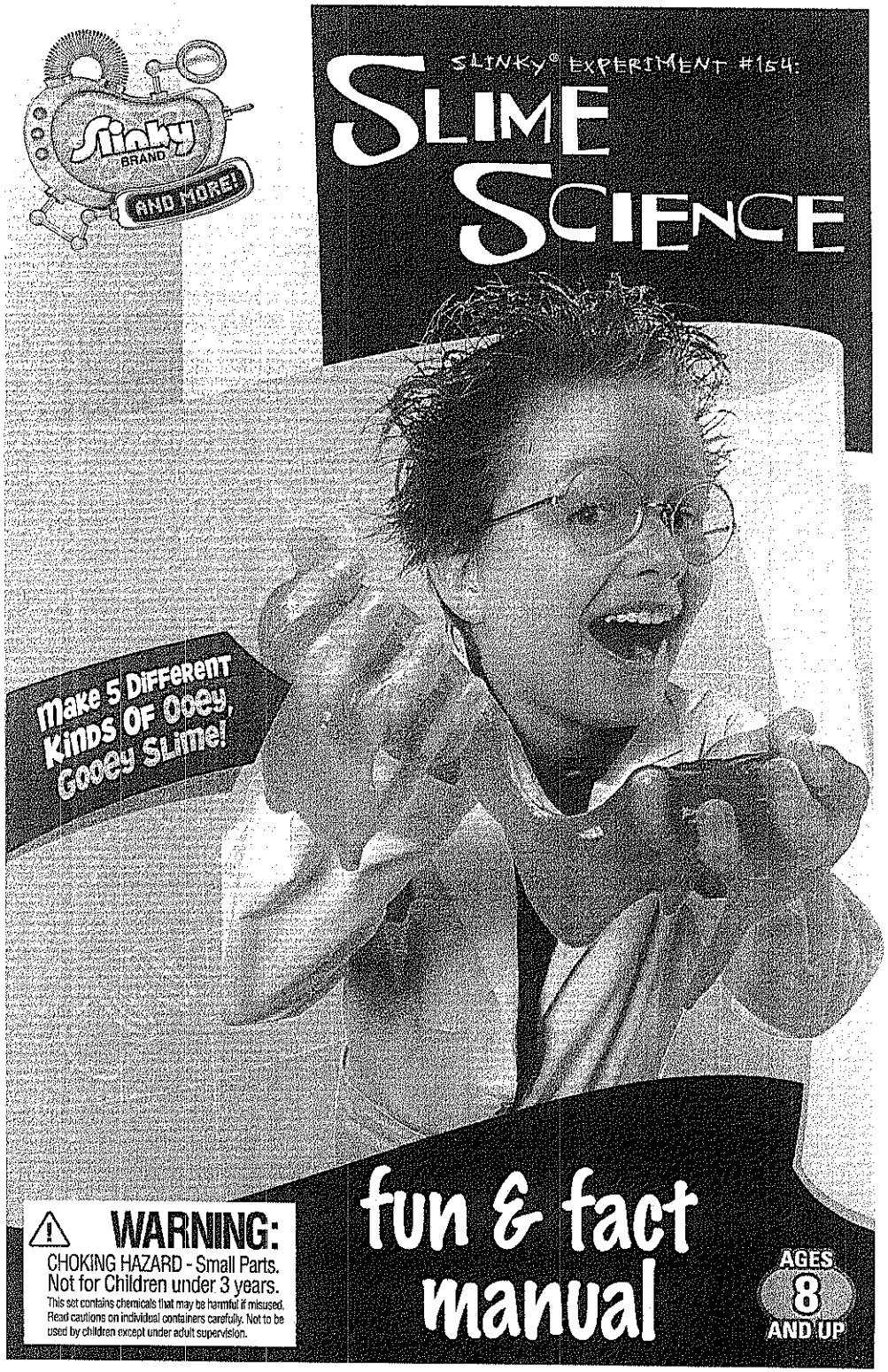
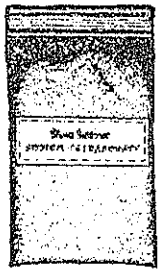

Slinky BRAND
AND MORE!
SLINKY® EXPERIMENT #154:
SLIME SCIENCE
Make 5 Different Kinds Of Ooey, Gooey Slime!
WARNING:
CHOKING HAZARD - Small Parts.
Not for Children under 3 years.
This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.
fun & fact manual
AGES 8 AND UP

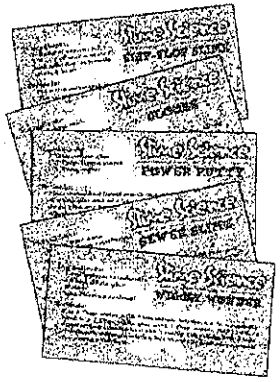
# WHAT IS IN YOUR KIT?


*Corn Starch*

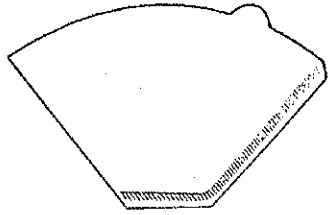
*Guar Gum*



*Borax (Sodium Tetraborate)*

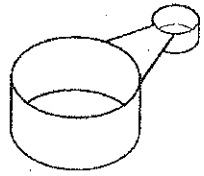


*Slime Recipe Cards*

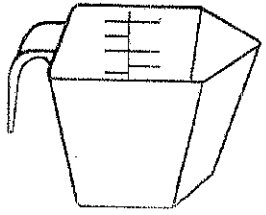


*Filter*

*Liquid Starch*



*Measuring Spoon (1 Tablespoon and 1/4 Teaspoon)*



*Measuring Cup*


*White Glue*

# Welcome to the Lab!

Congratulations! You are about to create things. Slimy things. Things that ooze in the night. Things you wouldn't want to meet in a dark sewer. But you won't be making these slimy things with hammer and nails. You will be creating with **chemistry**, using science to make changes in substances-sometimes very big changes!

With this great power comes responsibility. The chemicals you will use and make are safe, but you must use care and common sense in handling them. Two rules stand out above all:

> **- Keep your chemicals and slimes out of the reach of young children!**
>
> **-Keep your chemicals and slimes away from cloth or furniture-they may stain! Also, don't pour chemicals or slimes down drains-they may clog.**

Here are some other rules to follow to keep your slime science fun and safe:

- Set up your laboratory where you will have a clear surface to work.

- Lay out newspaper to make cleaning up spills easier.

- Keep your projects away from food.

- Label your chemicals clearly so they won't be mistaken for something else.

- Wash your hands and any tools you've used (like spoons, cups, or bowls) thoroughly with warm, soapy water.

- Put all of your chemicals and tools away when you have finished using them.



# Getting Started

What do you think of when you think of slime? You might think of the classic horror movie slime. Imagine how it feels-moist and sticky. Pick it up, and it slowly oozes out through your fingers. These facts-how it feels and how it moves- are a few of the **properties** of the slime. With this kit, you will be able to make five different slimes, each with special properties that you will hopefully find useful and fun. You may wish to keep a Lab Notebook handy to keep track of the special properties of each slime and the effects of a change in their recipes.

When you are done with each slime, seal it in a reclosable bag. Label the bag and store it in the refrigerator. Each slime will keep for a different period of time. Most will last for at least a few days before becoming moldy or unusable. That's another property you might want to keep track of!

# Activity 1: Sewer Slime

Let's start with that classic movie slime (so classic that its picture is on the box for this kit). Take a look at your Slime Recipe Card for Sewer Slime. The two main ingredients are **guar gum** and **borax** (sodium tetraborate). Guar gum is a natural material we get from a plant called, naturally, the guar plant. It is used to thicken many food products. Some ice creams use it as a cheap substitute for part of the milk or cream that is normally used. Borax is a mineral found in nature, which is used as a cleaning agent. It is also used to soften "hard" water.

***You need from your kit:*** guar gum, borax, measuring cup and measuring spoons.

***You need from home:*** water, reclosable bag, mixing bowls (disposable plastic ups work well), something to stir with (like a spoon)

1. Measure out 7 **table**spoons of water into a bowl or cup.

2. Measure out 1/4 **tea**spoon of guar gum. Add the guar gum to the water, only a little bit at a time. Stir as you add the guar gum, and keep stirring for a minute after all the gum is in the water. Let this solution sit for 3 to 5 minutes.

3. While you are waiting, pour 1 **table**spoon of water into another mixing bowl or your measuring cup. Mix 1/4 teaspoon of borax into this water. Stir this borax solution for 2 to 3 minutes.

4. Slowly add 1/2 **tea**spoon of the borax solution to the guar gum solution, stirring as your pour. Mix well and let stand several minutes, until it thickens.

5. If your slime doesn't thicken in 5 to 10 minutes, stir in another 1/4 teaspoon of borax solution. Let stand again.

Once your Sewer Slime has thickened up, it is ready to go. Pick it up and start playing with it! Take notice of its properties. What color is it? How does it feel? Is it sticky? Can you see through it? Can you stretch it? Will it run through your fingers? Does it look or act anything like the two solutions you started with?

## Polymers on Parade

So what exactly did you just make? Well, scientists call it a **polymer**- which is Greek for "Many Parts." A polymer is a big group of smaller parts, called molecules, all hooked together like a chain of paper clips, or a bicycle chain. The guar gum you started with was also a polymer. Lots and lots of the things you see around you are polymers, including plastics, rubber, and spider silk! Even wood is a combination of polymers with different properties.

Guar gum, by itself, looks kind of like Figure 1-a long chain. Your solution of guar gum and water is thick and syrupy, or viscous. All of those long chains of guar gum are tangled up together like a big plate of spaghetti!

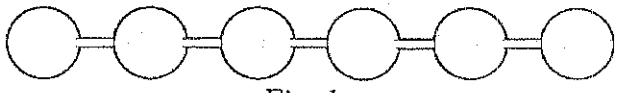


*Fig. 1*



What about the borax? Its job in this recipe is to take individual chains of guar gum and hook them together. Scientists call this **cross-linking**. But you don't get one really, really long chain, you get a net of connected chains, like Figure 2. The more borax you add, the more connected the chains of guar gum become, and the thicker the slime becomes!

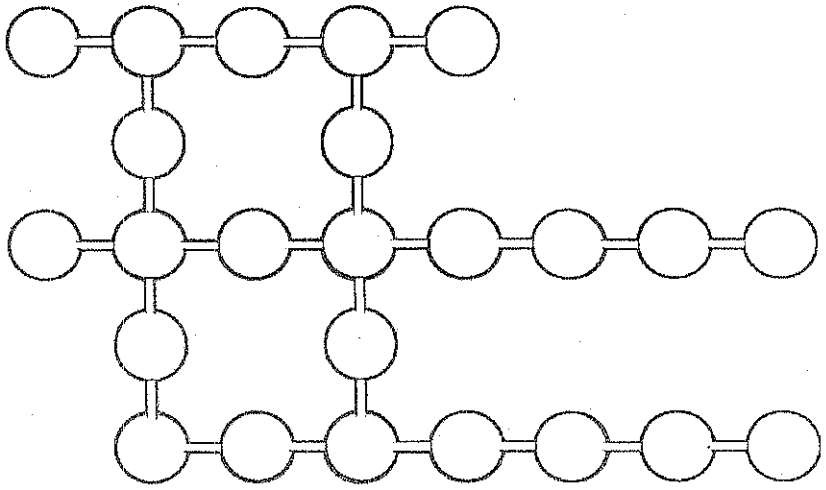


*Fig. 2*

## Activity 2: A Polymer Demonstration

***You need from home:*** a sheet of newspaper

1. Open up your sheet of newspaper. Tear partway down the page. Does the paper rip straight down between your hands or does it pull to the left or right?

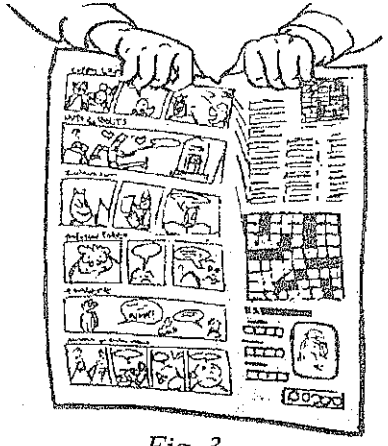


*Fig. 3*

2. Turn the paper sideways. That is, if the top of the sheet had been pointing to 12 o'clock, turn it so the top points either to 3 or 9 o'clock. Hold and rip the page again. Does the paper rip straight down or pull to one side?

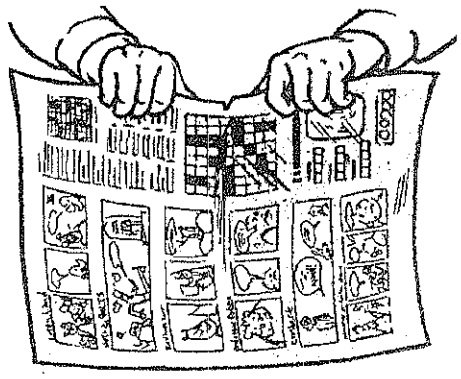


*Fig. 4*

What happened? Most of the time you should get a clean, straight tear one way, but a jagged tear the other. Why does this happen? Newspaper is made from a polymer called cellulose. When it is made, it is rolled out and pressed. That forces all the polymer chains to line up in the same direction. If you tear the sheet one way, you are ripping across many chains. That makes it very hard to get a straight tear. If you tear the other way, you are ripping between chains, making a straight tear much easier!

## Activity 3: Wiggly Wonder

Plain white glue contains a polymer called polyvinyl acetate, which can be cross-linked to create several different kinds of slime. This one almost seems to have a life of its own!

***You need from your kit:*** white glue, borax, measuring cup and measuring spoons.

***You need from home:*** cold water, reclosable bag, mixing bowls and stirrer.

1. Measure 6 **table**spoons of water into a mixing bowl. Stir in 1 teaspoon of borax and mix thoroughly.



2. Measure 1 **table**spoon of glue into a second mixing bowl. Try to scrape as much of the glue as is possible off the spoon and into the bowl!

3. Add 1 **table**spoon of water to the glue. Stir well.

4. Stir 2 **tea**spoons of borax solution into the glue solution. Keep stirring until it thickens.

What have you made this time? What happens as you hold the Wiggly Wonder? Try rolling it into a ball and holding it in your hand. How long will it keep its shape? Bounce or jiggle it from hand to hand. Does it feel a little like a water balloon-jiggling even after you stop moving it? Stretch it slowly. What happens? Now pull it quickly. Lay it on a piece of newspaper for a moment. What happens when you pick it up?

Borax plays the same part here that it did in the first slime. It cross-links the long chain polymers (remember Figure 1), turning something that was already pretty viscous into something much thicker (like Figure 2)! The slightest motion sends the whole thing shaking. Wiggly Wonder still isn't solid, though. Leave it alone for a few minutes-it will flow and puddle.

## Activity 4: Glooze

The previous slime used a type of glue as an ingredient. This slime is a type of glue! In fact, it's related to cottage cheese, as you'll see.

***You need from your kit:*** Filter, measuring cup and measuring spoon

***You need from home:*** skim milk, vinegar, baking soda, reclosable bag, mixing bowls and stirrer
You will need to leave the milk out for awhile to get it to room temperature. Don't forget it-you don't want it to go bad! Also, be sure to use skim milk-**whole milk won't work**. The fat contained in whole milk gets in the way of the chemical reaction you want.

1. Warm 7 **table**spoons of skim milk to room temperature. Pour into a mixing bowl.

2. Slowly add 1 **table**spoon of vinegar to the milk, while stirring. Keep stirring for several minutes and then let the mixture stand for several more minutes. Watch what happens!

3. Drain off the thin, runny liquid at the top into another bowl or the sink. Try not to lose any of the solid lumps that have sunk to the bottom. Let the mixture stand for another few minutes and pour off any remaining liquid.

4. Place the filter over the mouth of a glass as if it were a funnel (see fig. 5). IF you have a funnel, you can put the filter into it and hold the funnel over the glass. Pour the solid lumps you have left into the filter and let them drain for several more minutes.

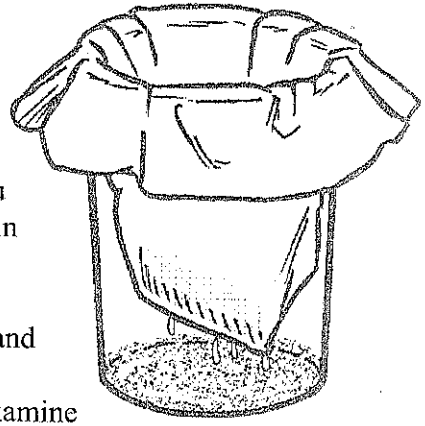


*Fig. 5*

5. Discard the liquid you have drained and pour your remaining solids into a clean mixing bowl. Discard the used filter. Examine the solids you have been left with. Do they look a little like lumps of cottage cheese?

6. Add 1/4 **tea**spoon of baking soda and 1 and 1/4 teaspoons of water to the solids and stir thoroughly. Don't be alarmed if small bubbles start to appear.

What happened? Take it step by step. First you warmed and mixed vinegar into the milk. Vinegar is mildly acidic. Acid causes part of the milk to separate out as a solid. This part is a natural polymer called **casein**. Casein is a main ingredient off cheese. It is also used in glue, in paints, and in paper cloth.

Unfortunately, casein is only a tiny part of milk, which is why we have to work so hard to get even a small amount. Your next few steps were all aimed at draining off everything but the casein.



Finally, baking soda is **basic**, the opposite of acidic. Adding baking soda balances out the remaining bit of vinegar. The casein can then mix with the little bit of water you add at the end to make Glooze. But where do the bubbles in your Glooze come from? Mixing baking soda and vinegar produces carbon dioxide gas (the same gas used to put bubbles in soda pop).

Now that you know what's going on, you should try out your Glooze before it dries out! Different kinds of glue have different properties, such as what they can stick together (or **bond**). Glooze works very well at sticking paper together. See what else Glooze works on. **Be sure to get permission before gluing anything together!**

## Activity 5: Flip-Flop Slime

You're pretty deep in Slime Science now. You know what "cross-linking a polymer" means. Better still, you know how to do it chemically-using borax with certain polymers. But are there other ways to tangle up those polymer chains? You bet! Let's make a Flip-Flop Slime that can't decide whether it wants to be a solid or a liquid.

***You nee from kit:*** cornstarch and measuring cup

***You need from home:*** warm water, reclosable bag, mixing bowl and stirrer

1. Measure 1/2 cup of cornstarch into a bowl.

2. Add 1/4 cup of water to the cornstarch. Stir until the slime is **smooth**. It may become hard to mix, but keep going!

Pretty simple instructions, right? Try a few simple tests.

- Poke the Flip-Flop Slime with your finger. Try poking both quickly and slowly. Can you poke all the way through it?

- Run your finger through the slime. Again, try it both quickly and slowly.

- Grab a handful and squeeze it.

- Roll the slime into a cylinder between your hands.

- Lay out some newspaper and place slime onto it. Smack the slime with your open hand.

- Pour all of your Flip-Flop Slime back into the bowl. Set something small, like a coin or a toy soldier, onto the slime.

What happened? Sometimes the Flip-Flop Slime is a runny liquid, but sometimes it's a solid! Did you see a pattern to when the slime acts liquid or solid? Stirring, squeezing, or even slapping it made it act like a solid, if the movement was slow or gentle, the slime stayed liquid.

This kind of behavior is so weird and interesting that scientists have a name for it. A **Non-Newtonian Fluid** is a liquid that gets more viscous (sometimes to the point of acting like a solid) when it is stirred or squeezed. You've probably seen one-quicksand-in movies or on television. In the very unlikely event that you fall into some quicksand, now you know what to do. Stay calm and try to float the way you would in a swimming pool. Paddle very, very slowly to dry land!

How does it work? Your Non-Newtonian Fluid, the Flip-Flop Slime, is what scientists call a **colloid**. A colloid is made up of tiny particles (cornstarch, in this case) hanging in something else (the water.) What makes a colloid special is that the particles are so tiny that they will hang there forever instead of settling to the bottom. A colloid that you probably are very familiar with is mayonnaise. Mayo contains lots of tiny beads of oil hanging in water.

So, Flip-Flop Slime is a colloid. What does that do for us? If you followed the recipe, your colloid slime is packed tight with cornstarch. Normally, the starch particles still have lots of room between them. If they move a little, there's space for them to slide around, and the slime stays liquid. But if they move a lot, the starch chains start tangling around. When that happens, the water acts as a cross-linker, and the slime becomes solid. But the linking only lasts for a little while.



As soon as the slime stops getting pushed around, everything unhooks and goes back to being a squishy liquid.

## Activity 6: Power Putty

Scientists often experiment with the recipes for the things they make. Small changes can affect the final product quite a bit. If the first attempt doesn't have quite the properties they are looking for, they change the recipe. Let's make a very small change to Wiggly Wonder-one of the slimes you've already made-and see what happens. All we need to do is use liquid starch instead of the plain borax and water mixture.

***You nee from kit:*** white glue, liquid starch, measuring cups and measuring spoons

***You need from home:*** cold water, reclosable bag, mixing bowls and stirrer

1. Mix 1/2 **table**spoon of liquid starch with 1/2 **table**spoon water in a mixing bowl.

2. Add 1 **table**spoon of white glue to the starch and water mixture. Try to scrape all of the glue off the spoon. Mix well for about one minute.

3. Add another 1 **table**spoon of white glue to the mixture. Mix well for another minute.

4. Let stand for several minutes to thicken. Don't worry of it is very sticky at first. You may need to squeeze and roll the Power Putty around for a few minutes to dry it off.

Compare the Power Putty to the Wiggly Wonder. Do they look the same? Do the feel the same? Roll each one into a ball shape and hold in each hand-what happens? Stretch out the Power Putty, slowly, then try pulling it quickly. Bounce it from hand to hand. Does it jiggle the way Wiggly Wonder does? Lay it on a sheet of newspaper.

jiggle the way Wiggly Wonder does? Lay it on a sheet of newspaper. Does it pick up the ink?

## Activity 7: New Slimes

You should have enough white glue, borax, and liquid starch left to do additional experiments. Based on what you now know, you should be able to make educated guesses about the effects of changing the recipes. What do you think will happen if you:

***- Add more (or less) water to the mixture?***

***-Add more (or less) borax to the borax solution?***

***- Add more (or less) liquid starch?***

Work like a real scientist. Write down your educated guesses about the results, and why you think it should happen that way. This is called a **hypothesis**. Then do an experiment to test your hypothesis. Follow your new formula and compare the results to your guess. IF you guessed wrong, can you figure out what happened?

For example, let's say you think that adding only 1/4 tablespoon of liquid starch to Power Putty should make it less bouncy. Write down the hypothesis. Then, mix up a new batch of Power Putty, changing the amount of cornstarch. Compare your original sample to the new batch. Hold them from the same height and let go. Which one bounces higher?