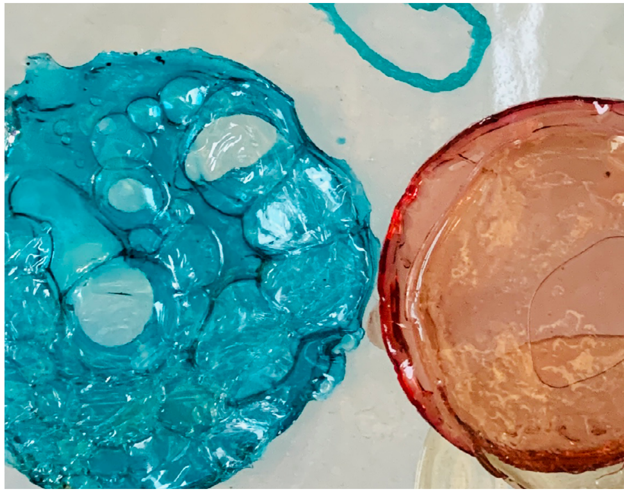
BIOPLASTICS KIT

BETA

MOLDING, TEXTURES & COLORS



www.amino.bio

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BIOPLASTICS KIT™
MOLDING, TEXTURES & COLORS
instruction manual

Getting Ready

The Experiment

More information

Welcome! Let's get started

This user guide was created to help you get the most out of your Amino Labs experience. Even if you are familiar with making new materials, bioplastics, science or other Amino Labs™ products, please take the necessary time to read through this guide. This will ensure you practice safe science as well as store, use, and get the most out of your kit. It will also let you know what to do in case of a spill or accident.

In the first section, you will learn about your kit's components, how to store them before and during your experiment, as well as a few tips on activities to complete before you get your hands 'wet'. The second section is procedural -- these are the step by step instructions on how to run your experiment. Make sure to follow our tips to ensure your best success! The third section covers "what's next"; how to keep your creations, store or dispose of any leftover ingredients and general clean up instructions. The final section is there to help you -- a glossary, troubleshooting, and our contact information.

Amino Labs is excited to welcome you to the world of Bio-design with the Bioplastics kit! The first in a series of experiment to get you making with biology! **Following this guide will help ensure that you are getting the most out of your current and future experiences to keep on making new creations. Have fun!**

Practicing safe science - Bioplastics

Science is a safe activity when you follow simple guidelines. Read on to ensure you adopt safe practices.

The kit in your hands contains only inert ingredients - no live organisms. The ingredients are all safe to use without any special containment or training. Most of the ingredients will be familiar to you from your kitchen. Even though these are familiar, you should never eat or taste any part of this kit, or any ingredients you use for science experiments. Follow these safety guidelines for your safety and the success of your experiment(s)!

We recommend the system and kits for ages 12+, under adult supervision, and 14+ with or without supervision. The cleaning instructions must be strictly followed for safety and experiment success. Make sure to store the kit per the instructions found in this booklet.

- Do not eat or drink near your experiments. Keep your experiment at least 10 feet from food, drinks, *etc*. Under no circumstances should you eat any of the kit's content.

- Wash your hands before and after your experiment,

- Wear gloves, is recommended even when cleaning your station or handling the kit contents as part of a safe science practice. This will protect you from your experiment, and your experiment from you. Any latex, nitrile, or general purpose gloves you can find at the pharmacy will do. After you put your gloves on, be aware of what you touch. Try not to touch your face or scratch itches with your gloved hands!

- Clean up your work station, spills and work surface before and after use. Use a 10% solution of chlorinated bleach generously sprayed onto a paper towel and rub onto any contaminated surfaces. (Careful! This can discolor your clothes). A chlorinated spray cleaner also works.

- With the Bioplastics kits, all the discarded materials can go in the garbage. Do not pour bioplastic mixture down the sink. Find a container to hold the inactivation bag where you will discard used items. If you are familiar with other Amino Labs kit, you can use a discard container at your station to hold all your materials, just like when doing your genetic engineering experiments.

- **Eye-wear is not provided but can be worn.**

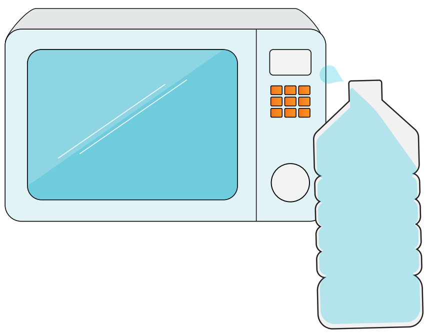
While these also include rules specific to experiments with live organisms, you can still download a biosafety poster for your space from www.amino.bio/biosafetyinaction and complete a short safety quiz at www.amino.bio/biosafety-quiz

If you would like to do a short Online lab safety course for your edification, we recommend a Government of Canada course: www.amino.bio/biosafety

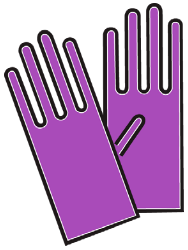
Unpacking and storing kits

For a better shelf life and a successful experiment, place your kit at **room temperature,** away from the light.

Items you will need



- **Access to a microwave**
- **Marker or pen**
- **Paper towels for clean up**
- **A mixing utensil** like a spoon (metal, plastic or wood is ok!)
- **Distilled or tap water** (~100 mL)



Necessary safety supplies

- **Optional: Latex/nitrile gloves** like those found at a pharmacy. 1 pair/person
- **Soap and/or spray cleaner** bottle for cleanup

The Big Plastic Problem & bio-based plastics

Plastics are a well-known material that is used to make our modern world go round. There is a high probability that you have many types of plastics around you right now. Can you spot them? You may see an appliance, electrical cord, clothing, shoes, pet food or water dish, or a garbage bin. You'll likely notice many types of plastics with many different properties. But did you know that all plastics have a similar basic chemical structure?

What are exactly are plastics?

Plastics are chains of repeating molecules linked together. These "strings" of repeating molecules are called polymers. Since these chains are called polymers, plastics are also often called polymers. You might have noticed that many plastic names start with "poly ." Now you know why! Different plastic properties are a result of the types of atoms and molecules that make up the polymer chains. These repeating molecules can either all be the same (also called a monomer) or by a few different molecules that repeat in a pattern (a true polymer).

The process of creating plastics is called polymerization. During polymerization, the smaller molecules, called monomers or building blocks, are chemically combined to create the polymers. The first "modern" plastic was Bakelite, a material that could not be melted again when formed. Bakelite was introduced in 1907 by chemist Leo Hendrik Baekland. He also coined the term 'plastics' to describe this new category of material. Since the introduction of plastics, most polymers have been produced with petrol-based compounds because petroleum-based compounds are cheap, easy to obtain and process, and very durable.

Bakelite buttons. Source: Science History Institute, CC BY-SA 3.0, via Wikimedia Commons

Just what is the Big Plastic Problem?

You might be aware that many scientists, innovators, and students like yourself are now looking to biology to solve the big plastic problem. Why? Because traditional plastics have three significant impacts on the environment: they use fossil fuels, they have a large carbon footprint, and they stay in the environment for hundreds of years. One major thing scientists are working on is that plastic is too durable! Most petroleum-based plastics are not biodegradable; instead, they degrade so slowly that they stay in the environment, landfills, beaches, and oceans for decades up to hundreds of years. While several factors impact the timeline to degrade plastics, like the polymer it is made from and the environment it is discarded in, on average a single-use plastic bottle will take about 450 years to degrade, while a plastic bag can take anywhere from 10 to 1,000 years to degrade in a landfill. That's a very long time for something that is used for less than a few hours. Crazy!

Plastic debris disintegrates over time into smaller particles of various sizes and shapes under natural processes like UV radiation and mechanical abrasion. These are referred to as secondary microplastics and form more than 80% of microplastics found in the environment. Source: Oof.cc, CC BY-SA 4.0, via Wikimedia Commons

And the problem doesn't end there. As we continue to learn about the presence of plastic in the environment, science indicates that some of these petroleum-based plastic actually do not entirely go away, even after all these years. If they are not recycled into new plastic products, some petroleum-based plastics like PVC will break down into smaller pieces that stay in our environment, water systems, and soil. These are sometimes referred to as "forever plastics" or microplastics, and they've been found in all our oceans, marine life, drinking water, and even in human bodies! While the impacts of these microplastics on living organisms, plants, animals, and human health are still being studied, there is just no escaping them. Scientists have seen microplastics in most places they have looked: In deep oceans, in Arctic snow and Antarctic ice, in shellfish, table salt, drinking water, human blood, and even drifting in the air or falling with rain over mountains and cities.

This is why more and more people are looking into ways to degrade existing petroleum-based plastics. But oth-

Gelatin-based bioplastics dyed with algae extract.

ers are also working to create new types of plastics that won't have these problems. These plastics would be made with biological materials that can degrade quickly, would not rely on fossil fuel as a source, and would have a smaller carbon footprint.

What are bioplastics?

These new types of plastics made with biological-based ingredients are called bioplastics. And early research indicates that they could be a significant improvement over petroleum-based plastics. To be specific, bioplastics are plastics made at least in part with renewable biological matter (like vegetable fats and oils, corn starch, woodchips, sawdust, and food waste), or they are plastics that can degrade in a reasonable time.

It might surprise you to learn that bioplastic production is much older than the petrol-based plastics we use today! In 1500 BC, people in Egypt were already using materials made of gelatin and casein (a protein found in milk) for furniture constructions. And it's not all ancient history either; in the 1940s, industrial pioneer Henry Ford experimented with soya bean plastics. Cool! That means that the history and potential of bioplastics is rich and inspiring.

Today, bioplastics are being developed and tested as sustainable replacements for single-use plastics for packaging, utensils, food containers, 3D printing, fashion, and even medical implants. But since bioplastics have different properties than their petroleum-based counterparts because they are mostly made from biodegradable ingredients, it can require an innovative mindset to use them industrially. For example, since some bioplastics use ingredients that can dissolve in water, the bioplastics themselves can also dissolve in water. This property can be an advantage in some situations, but it can also limit its use: For example, bioplastic utensils and bowls that dissolve in liquid will not be much help to bring your leftover soup home, or as a water bottle. Like any technology, bioplastics will have their ideal use cases, current limitations, and potential for improvements.

So now it is your turn to join bioplastics innovators! Let's go forward and learn how to make bioplastics.

Discover your Bioplastics Kit™

With the Bioplastic Kit series, you'll be able to combine different biological ingredients to create a fun new materials: bioplastics. With the kit you have now, you'll use common bioplastic ingredients and combine them to dyes, powders and liquids to create different textures and tints. You'll also learn how to mold your bioplastic to create fun shapes. Following the kit's instruction will also help you learn some of the basics skills of making materials.

By following the experiment instructions on the next pages, you will:

- discover some ingredients used in bioplastic: gelatin, glycerol, and water
- gain or improve your making skills like mixing, measuring, casting, colouring and texturing bioplastics.

This kit can be used alone or in a small group (with parent supervision if you are 14 or under). In the next pages, you will find descriptions of the kit's content.

Kit components

Tube of glycerol: Glycerol (sometimes also called glycerin) is a colorless, viscous liquid that helps softens and reduces shrinkage in bioplastics. This is because glycerol functions as a plasticizer that bonds with the polymer in your mixture. A plasticizer is something that is added to another material (usually a plastic base) to make that material softer or more pliable.

Gelatin: Gelatin is a colorless powder derived from collagen, which acts as a binding material and a hardening component in bioplastics. It often functions as the polymer in your mixture.

Baking Soda: Sodium bicarbonate, commonly known as baking soda or bicarbonate of soda, is a salt composed of a sodium cation and a bicarbonate anion. You'll most often find it in a white powder form. In bioplastics, in can be used to give opacity to the material, and to create textures.

Tube of liquid soap: A soap solution to texture a bioplastic (may be found in the weigh bag for some kits)

Tube of oil: This tube of vegetable oil will help you lubricate your mold and containers to easily take out your bioplastics once dry. If you make bioplastics outside of this kit, you can use household oils, like olive, canola or coconut as mold lubricant (also called mold release).

Blank labels: These blank sticky labels will help you keep track of which containers have which bioplastics as they dry. If you make more bioplastics in the future, you can use masking tape to replace the blank labels.

Petri dishes bag: You will use these petri dishes to mix and/or dry your different bioplastic mixtures.

Red, blue and yellow dyes, 3 plastic pipettes: 3 tubes of dyes and 3 pipettes to help you dispense them in your bioplastic mixture. Each pipette is assigned a color to prevent contaminating your different dye colors.

Mold: A star-shaped mold to give shape to some bioplastic.

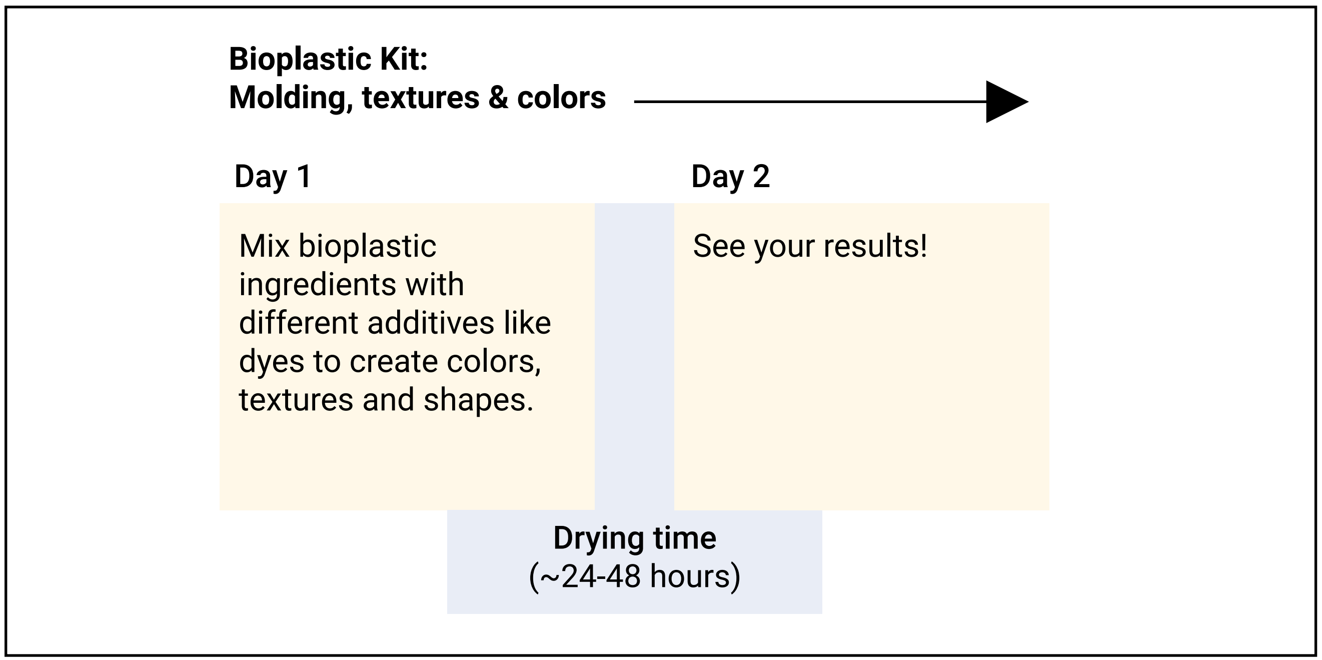
Pipette: While disposable, this plastic pipette can be easily rinsed and reused to texture your bioplastics.

Toothpicks: While disposable, these toothpicks can be easily rinsed and reused to mix your bioplastics and help remove them from their molds.

Optional : Measuring/mixing beaker: A beaker help you measure and heat the water you need to make your bioplastics, and to mix your ingredients in.

Timeline

Your kit enables you to complete one full bioplastic experiment, which will take ~50 minutes,plus drying time for the bioplastics. The drying time is about ~72 hours, depending on where you are. By placing the drying plastics in a hot, dry location, like near a heat vent, you can speed up drying.



Bioplastic molding, textures & colors
Explore the world of bioplastic:

Day 1, 50 minutes
Dry time 24-48 hrs
Day 2, 15-30 minutes

A key pitfall to avoid!

In the next pages are detailed, step-by-step instructions to complete the experiment. **It is helpful to read through all of the steps for each part of the activity before starting that day's activity.**

While all the steps outlined in the experiment are important and should be followed as described, the MOST IMPORTANT consideration for success is:

Always make sure that the water is boiling before adding any powder or liquid to make sure the ingredients will fully dissolve. <u>**You have to see the water bubbling**</u>**!** Be careful, the bottle or bowl will be hot!

Experiment Protocol

Prepare your space

Goal Set yourself up for success.

Materials from the kit

Materials not in your kit
Spray cleaner
Paper towels
Pair of gloves

Make sure you have the necessary materials as described on page 5, including access to a microwave, and water before you start. Also make sure that you have read and understood the safety guidelines.

1. If you have them, put on your gloves, and an apron or lab coat.
2. Remember that you can dispose of used items in the garbage but that you should **not pour liquid bioplastic mixture down the drain as it could solidify in the drain**. When you are ready to dispose of your used bioplastics or any extra mixture, you can let it dry before scooping it out into the garbage, or you can pour it directly in a garbage bag.
3. Choose a work surface that is stable, non-porous and easy to wipe (non-porous surfaces are smooth and sealed so liquid cannot go into them, like glass, plastic, varnished wood). Wipe down your work surface with a spray cleaner before starting
4. You will need to let some of your bioplastics dry for up to ~72 hours in the mold/containers provided in your kit. Once the hot bioplastics are poured into the molds, try to avoid moving the containers for about 20 minutes until the mixture solidifies. This will help avoid spills. After that time, the mixtures will be solid enough for you to move the molds to a more convenient location for longer-term drying.

1. Prepare your bioplastic recipe 10-20 minutes

Goal Gain bioplastic skills by making a bioplastic product.

Materials from your kit
1x packet of gelatin (10 g)
1x tube of oil
1x small tube of liquid soap
1x tube of glycerol (10 mL)
8x labels
Petri dish bag
Beaker

Materials you provide
1x mixing utensil
Microwave
Paper towels
Marker/pen
75 mL Distilled or tap water

Today, you will learn how to transform bioplastic colors, textures, and shapes. You'll split up one bioplastic recipe and use different tools and techniques to change the visual and tactile properties of the bioplastics. You'll then be able to apply them to all other bioplastics recipes you'll learn throughout this kit series and beyond.

Prepare

1.1. Set your star-shaped mold and 4 petri dishes on a flat surface. Open up the petri dishes as you will be using both the lids and bottoms to hold your bioplastics.

1.2. Add oil on a paper towel and "paint" the insides of the star mold and the petri dishes with the oil. This will prevent the bioplastics from sticking to the surfaces as they dry. The oil will act as a mold release.

1.3. Take the 8 labels and write the following on them: "Mixing", "blown bubble", "soap foam", " baking soda", "1 dye drop", "5 dye drops", "10 dye drops", "15 dye drops"

1.4. Stick your labels on the outside of the petri dish:
- "1 dye drop", "5 dye drops", "10 dye drops", "15 dye drops" one on each bottom part of the petri dishes (the bottoms are the bigger sides).
- "Mixing", "blown bubble", "soap foam", " baking soda" one on each lid side of the petri dishes.

Make the bioplastic mixture

1.5. Measure **75 ml** of water in your beaker. Use the graduated lines of the side of the beaker to help measure.

1.6. Microwave the water until you see the water boil (big bubbles). This should take around 1 minutes. It is better to microwave for too long than not enough.

1.7. Take your beaker out of the microwave. Careful! The water and beaker will be hot. You can wrap a paper towel around it to help hold it.

1.8. Add the full content of the tube of glycerol (**10 mL**) into the beaker.

1.9. Add the full content of the gelatin bag **(10 g)** into the beaker and stir with your mixing utensil until roughly combined - it's okay if there are some clumps for now.

1.10. Microwave the mixture for 25 seconds, or until you see foam form.

1.11. Stir until the mixture is smooth. If clumps persist after stirring, you can microwave the mixture for 5 additional seconds and stir. Repeat until no clumps remain. You can add a bit more water, little by little if the clumps won't dissapear with mixing and microwaving.

Note: **Always be careful when holding the beaker after you microwave it as the bioplastic will be hot.**

2. Make a bioplastic star, 5-10 minutes

Goal Mold bioplastic mixture into a star shape

Materials from your kit
Bioplastic mixture from the first step
'Mixture' petri dish
Toothpicks
1x star mold
Dye bag

Materials you provide
Paper towels

1x packet of baking soda

Casting is a manufacturing and crafting process in which a liquid material is poured into a mold and allowed to solidify before it is taken out. The mold contains a hollow cavity of the desired shape. In this experiment, your mold has the shaped of a star. Some of your favorite objects are made this way, from jewelery to Lego blocks!

Prepare your mold

1.1. Make sure your star-shaped mold is on a flat surface, where you will be able to leave it for at least 20 minutes before moving it for longer term drying.

Dye your bioplastic

1.2. Pour **~ 10 mL** of bioplastic from your beaker and dispense it into the petri dish labelled mixture.

1.3. Take the dye bag and add 1 drop of colored dye of your choice to your liquid bioplastic. Each pipette has been assigned a color with a dot on its label. Use the corresponding pipette with the colored dye to prevent mixing the source tubes. Keep your dye pipettes; you can place them on your paper towel for later use

1.4. Using your stirring utensil or a toothpick, stir until the color is fully combined.

Cast your bioplastic

1.5. Pour the bioplastic mixute into your star mold until the liquid bioplastic reaches the top but does not overflow. Go slowly! You may have any leftover mixture in your petri dish, and that's ok. You can leave it in the petri dish to dry.

Dry

1.6. Dry the bioplastic star ~ 3 days (72 hours), or until it is no longer soft/wet to the touch. The bioplastic start to solidify after 10-20 minutes. Once it is no longer "jiggly" when you touch the mold, you can move it to another drying spot if you need.

3. Make a blown bubble texture, 5-10 minutes

Goal Use a pipette to change the texture of your bioplastic

Materials from your kit
Bioplastic mixture from the first step
'Blown bubble' petri dish
Toothpicks
1x plastic pipette
Dye bag

Materials you provide
Paper towels

For the blown texture, you will create the texture on the surface of your bioplastic by infusing it with air. You will first color the bioplastic, then, after letting it solidify for a few minutes, you'll inject air into it with your plastic pipette.

Dye your bioplastic & let sit

1.1. Pour **~ 10 mL** of bioplastic from your beaker and dispense it into the petri dish labelled blown bubble.

1.2. Add drops of colored dye of your choice to your liquid bioplastic and stir until the color is fully combined.

1.3. Let the mixture sit in the petri dish for about 5-10 minutes. The bioplastic has to start solidifying before you create the texture. You can skip ahead to the next texture and come back here afterwards. (After 5-10 minutes)

Add bubbly texture to your bioplastic

1.4. Take your petri dish and the plastic pipette. Place the pipette tip inside the bioplastic so that the tip rests the bottom of the container at a slight angle.
Note: You can try different angles between 0° (straight up) and 45° to find what works best for you as you go through the next steps.

1.5. Gently press on the pipette bulb to release the air that was inside the pipette into the bioplastic mixture. You should see bubbles appearing at the surface. The bioplastic mixture must have started to solidify for the bubbles to stay on the surface.

1.6. Take the pipette out of the mixture and release the bulb to pull in air. Place back into your mixture and repeat making bubbles until the surface is covered.
Note: Smaller bubbles pop less easily and create more texture when the bioplastic dries

TROUBLESHOOTING: If your bubbles deflate immediately, let the bioplastic rest for an additional 1-2 minutes so that it continues to solidify before trying the bubbles again. If the mixture has solidified too much, you can always microwave it for a 2-3 seconds to bring it back to a more liquid form.

Dry

1.7. Dry the bioplastic for ~3 days (72 hours), until it is no longer soft to the touch. For the next 10 minutes, the bioplastic will continue to solidify, after which you can move it. You can keep an eye on it as it dries in case you want to repeat blowing air in if the bubbles pop as it dries.

4. Make a powdery/gritty texture, 5-10 minutes

Goal Use a powdered ingredient to change the texture of your bioplastic

Materials from your kit
Bioplastic mixture from the first step
'Baking soda' petri dish
Toothpicks
1x packet of baking soda
Dye bag

Materials you provide
Paper towels

For this texture, you will create a gritty texture on one side of your bioplastic using powdered baking soda. The weight of the baking soda will make it sink to the bottom of the dish, creating a different finish on that side once its dry.

Dye your bioplastic.

1.1. Pour ~ 10 mL of bioplastic from your beaker and dispense it into the petri dish labelled blown bubble texture.

1.2. Add drops of colored dye of your choice to your liquid bioplastic and stir until the color is fully combined.

Add your baking soda

1.3. Open your bag of baking soda and pour all of it into your mixture.

1.4. Using your toothpick, mix the powder into solution. You will see the powder sink to the bottom of the dish as you mix. Let the powder sink to the bottom, and use your toothpick if any clumps persist.

Dry

1.5. Dry the baking soda bio-foam for ~3 days (72 hours), or until it is no longer sticky to the touch. You will notice the bioplastic start to solidify after 10 minutes or so. Once it is no longer "jiggly" when you touch the mold, you can move it to another drying spot if you wish.

If you completed this texture while your blown bubble bioplastic mixture was solidifying before you add the air, don't forget to go back and finish that section of the experiment!

5. Color tests, 5-10 minutes

Goal See how different quantities of dye change the bioplastic

Materials from your kit
Bioplastic mixture from the first step
4x ‘Dye drops’ petri dish
Toothpicks
Dye bag

Materials you provide
Paper towels

It’s time for you to see if increasing the dye content in the bioplastic affects its material properties. You will increase the amount of dye in 4 petri dishes, as follows:

- Dish 1: add one drop of dye.
- Dish 2: add four drops of dye for a total of 5 drops of dye in the mixture.
- Dish 3: add five drops of dye for a total of 10 drops of dye in the mixture.
- Dish 4: add another five drops for a total of 15 drops.

Prepare your containers

1.1. Take your 4 petri dish bottoms labeled with “1 dye drop”, “5 dye drops”, ”10 dye drops”, and “15 dye drops” and place them on a flat surface.

Color and dispense your bioplastic

1.2. Choose one of the 3 colors: yellow, blue or red.

1.3. Add 1 drop of your chosen dye directly into the remaining liquid bioplastic in your large beaker. Stir until the color is fully combined.

1.4. Pour ~10 ml of the dyed mixture using your large syringe and dispense it into the petri dish labeled “1 dye drop”.

1.5. Add 4 drops of the same dye to the liquid bioplastic in the beaker (for a total of 5 drops, counting the 1 drop you already added). Stir until fully combined and dispense another ~10 ml into the petri dish labeled “5 dye drops”.

1.6. Add 5 more drops of the same dye to the beaker of bioplastic (total of 10 drops), stir until combined, and pour ~10 mL into the “10 dye drops” petri dish

1.7. Add a final 5 drops of the same dye to the beaker (total of 15 drops), stir until the color is fully combined and pour ~10 mL into the “15 dye drops” petri dish.

Dry

1.8. Dry the bioplastics for 3 days (72 hours), or until they are no longer soft/sticky to the touch. After 20 minutes or so, you can move them to another drying spot.

6. Soap foam texture, 5-10 minutes

Goal Use a liquid ingredient to change the texture of your bioplastic

Materials from your kit
Bioplastic mixture from the first step
'Soap foam' petri dish
Toothpicks
Dye bag

Materials you provide
Paper towels

For your final texture, you will use soap to create a different type of foam texture in your bioplastic.

Prepare your bioplastic mixture

1.1. You will be using the remaining bioplastic in your beaker for this step. If you want, you can add some drops of red or yellow dye to change its color.

Foam the bioplastic

1.2. Pour the entire contents of the soap tube from your kit into the large beaker and use your mixing utensil to vigorously stir in the soap, creating bubbles as you go. The more vigorous your mixing, the more bubble you will get!

1.3. Pour some of your mixture, foam and all, into your petri dish lid labeled "foamed plastic" until it is full, but not overflowing. You may have leftover bioplastic foam. You can pour it into your empty 'mixing' petri dish, or discard of it in the garbage can.

Dry

1.4. Dry the bioplastics for 3 days (72 hours), or until they are no longer soft/sticky to the touch. After 20 minutes or so, you can move them to another drying spot.

Wash up

1.5. Wash your beaker, stirring utensil, measuring syringes and any other item that has touched wet bioplastic mixture with hot water in the sink. Rinse well with water, until you can no longer smell soap. Dry with a paper towel.

7. See your results, 5-10 minutes

Goal Learn from your experiment

Materials from your kit
All your bioplastics

Materials you provide
Paper towels

See Your results

1.1. Once your plastics are dry (no longer gel-like to the touch), remove them from their containers by running a toothpick between the edge of the bioplastic and the container. Grab a corner of the bioplastic to slowly and gently peel it up.

Learn from your experiment

1.2. What differences are there between all your bioplastics? Have a look at each sample and compare them to each other. If you are interested in doing material science analysis to evaluate their different properties, use this google document: https://amino.bio/bioplastic-texture-color-analysis

CONGRATULATIONS

You have now joined the global community of bio-designers and material innovators! Happy with your results? There are many opportunities to share it online and in your community. You can also share your results with friends and our growing community: find us on Instagram, Twitter, TikTok and Facebook @aminobiolab

Don't forget, you can use these recipes again and again using ingredients you may already have at home, or that you can find at the grocery store, or at Amino Labs. For now, let's make sure you dispose of and store your remaining material correctly.

Storage, Disposal, Clean Up

After you see your results and end the experiment, it is time to clean up, dispose of and store away your materials. Disposing of experiment materials is an integral part of experimental protocols.

A. **Preserving your bioplastic(s):** If you want to preserve your bioplastics for future reference, you can place your samples/work with an identifying labels in a container. Or, you can attach them in a binder along with any experiment notes and material property analysis.

B. **Disposing of your bioplastics:** If you would like to dispose of all or some of your bioplastics samples, you can place these in the garbage, melt them down, or place them in the compost pile. Unfortunately, the bioplastics you've made cannot go into the traditional recycling stream as the recycling industry is not ready to deal with these.

C. **Disposing of your other kit material:** All tubes, bottles, containers and plastic packaging can be disposed of in a recycling bin or garbage. Of course, they can also be washed and kept for reuse. Wash with soap and water and kept for reuse around the house/classroom.

D. **Unused ingredients/items:** If you did not use all of your ingredients, you can keep them in a sealed bag for reuse later. If the ingredients are in powder form, make sure the lid of the container/tube is tight to prevent the powder from humidity. Do not eat or cook/bake with any of your science kit ingredients!

E. **Clean your workspace:** Use a spray cleaner, wipes, or hot, soapy water to clear up your work area and equipment. If you are using a bleach cleaner, always wear gloves and remember that the bleach cleaner can discolor clothes and fabrics.

Glossary

Acetic acid: You'll have noticed that acetic acid is a clear, colorless, organic liquid with a pungent odor similar to household vinegar. Indeed, acetic acid is the main component of vinegar apart from water and trace elements. Regular vinegar is around ~4% acetic acid.

Acetic acid has a variety of uses, including as raw material and solvent in the production of other chemical products, oil and gas production, and in food and pharmaceutical industries.

The acetic acid in the recipe helps the starch fully dissolve in the mixture because starch dissolves better in the presence of electrically charged ions which the acetic acid provides.

Large cellulose molecules, like starch, are long-chain polymers. In this experiment, two ingredients change the properties of the polymer plastic. By adding a small amount of acetic acid, you break up some polymer chains, making the plastic less brittle.

Algae/Agar Bioplastic: Agar is a yellowish powder that comes from algae. It acts as a binding material and a hardening component in bioplastics. In addition, it functions as a polymer in bioplastic mixtures.

Agar is a polymer created from the agarose and agaropectin found in the cell walls of red algae. It is often used as a vegetable replacement for gelatin. It is used as a thickening or gelling agent in cooking. However, agar is more flexible than gelatin. You can combine gelatin powder with agar powder to make a more flexible/hybrid material.

Agar bioplastics are a suitable replacement for disposable single-use packaging, including snack packaging and dry food packaging. And, if you've done any biotechnology or microbiology, you'll recognize agar from the substrate that microorganisms grow on. It's the same ingredient, used differently. A fun fact about agar: it affects touch capacitive screens! You might be able to make an agar bioplastic stylus for your tablet!

For agar to work successfully, it first needs to absorb water which it does by being brought to a boil (100°C) It becomes a gel at room temperature since it solidifies at 32–40 °C. Solid agar gels will start melting at 85 °C.

Agar does not hydrate (absorb water) well in acidic liquids, making gelling difficult. To use agar alongside an acidic bio-plastic ingredient, first hydrate the agar in water, allowing it to dissolve, before adding it to your acidic ingredient.

Agar shrinks a lot in size and thickness over time, and if left in a mold where it's connected to wooden edges, it will form cracks in the center. So make sure to cut the agar free from the edges of the mold after the first 24 hours of setting.

Agar bioplastic should decompose for two months in summer temperatures, taking approximately four months in cooler climates.

Biocomposites bioplastic: Biocomposites are made from a matrix of plastic and renewable fillers. Biocomposites can be made entirely of bio-based ingredients (biocomposite bioplastics) or with bio-fillers to replace some of the petroleum-based content of traditional plastics. In adding bio-fillers to traditional plastics, non-renewable ingredients can be drastically reduced.

Bio-fillers: are organic materials that are ideally waste by-products of other industrial processes like agriculture or paper processing and combined into plastic recipes to provide different properties or limit the number of other ingredients. They are sometimes referred to as biomass. Fillers can help the material keep its shape and reduce the natural shrinkage in most bioplastic.

You can use different bio-fillers in biocomposite to obtain different materials properties. Popular bio-fillers are dried peels, eggshells, dried plant leaves, shredded paper waste, seafood wastes like shells, starch, or wood dust. You can add natural colorant by choosing naturally colorful bio-fillers.

You can also try to mix in your bio-filler to a gelatin-glycerol bioplastic recipe instead of a pectin recipe to obtain different properties.

Cornstarch: see starch

Drying: when a material dries, it can shrink and deform as the water leaves the mixture. You can remedy this by placing heavy objects on your drying plastic to compress it into the desired shape. You should always dry your bioplastics indoors and away from direct sunlight and pets, insects, and younger siblings. While many ingredients in bioplastic can be found in foods, you should never eat any of your experiments.

Gelatin: is a colorless powder derived from collagen. It acts as a binding material for bioplastic mixture and a hardening component. It also provides transparency to the piece. Gelatin functions as a polymer in bioplastics.

Gelatin bioplastics are clear, strong, oxygen permeable, and hygroscopic. The properties of gelatin bioplastics are influenced by drying temperature. When Gelatin bioplastics are dry, especially when exposed to the sun, they often get quite brittle. Even when adding more glycerol to the recipe, it is still one of the stiffer bioplastics to work with. Gelatin bioplastics can also be heated up or whetted to shape them over forms/molds and melted back down for reuse.

Gelatin is primarily used as a gelling agent in food, pharmaceutical, and cosmetic industries. When it comes to gelatin bioplastics, they can be used for alternative packaging, to create a folder/pocket, to replace stiff plastic materials you might use in your daily life.

Gelatin is often an animal-based ingredient. Some might find it problematic to use resources that require killing an animal because of religious or animal welfare beliefs. Arguments are also made that as long as there’s a meat industry, it is better to use products from the entire animal, including skin and bones. Some might consider gelatin a product that comes from a waste stream, but this is considered controversial by others. To avoid using animal-based gelatin, use agar or vegetarian gelatin.

Glycerol: is a colorless viscous liquid that helps give shape, softens, and reduces shrinkage in bioplastics. Glycerol functions as a plasticizer that bonds with the polymer in your mixture. Sometimes also called glycerin, although glycerol is a pure form, while glycerin is a mixture that contains 95% glycerol.

Glycerol is a sugar alcohol derived from animal products, plants, or petroleum (as a by-product of bio-fuel). It can also be obtained from micro algae oils, and it can be recovered from used cooking oil.

Glycerol has a low melting point (18°C) and high boiling point (290°C), which makes it suitable as a plasticizer in bio-materials. As a plasticizer, glycerol "lubricates" the plastic. If you want the plastic more pliable, add more glycerol. If you want the plastic to be stiff, add less glycerol. However, higher glycerol concentration makes the bioplastic weaker (low tensile strength), more fragile, and easier to degrade under wet and dry soil. But the flexibility of your glycerol bioplastic will make it easier to peel them out of their drying containers.

In biomaterials, glycerin can be used as a plasticizer for more flexible bioplastics, as moisturizer or softener in tanning (e.g., bacterial cellulose), as an additive for bubbling textures/mixes, and as a solvent for pigment extraction. It has antimicrobial properties.

Material sample: in general, a sample is a limited quantity of something intended to show what the whole is like. A material sample of bioplastic is then a small piece of bioplastics that you can use to understand how a larger quantity of the material would behave and what it could be useful for.

Material samples library: is a resource for material research, exploration, and experimentation consisting of an expanding collection of material samples, analysis, and notes.

Mold: a mold is a hollowed-out shape filled with a liquid or pliable material like plastic, glass, metal, or ceramic. The liquid hardens or sets inside the mold, adopting its shape. Molds are sometimes called forms or negative forms and are often used to replicate a "master" item. The mold you select will affect both the shape of your material as well as the drying process. For example, thicker materials will take longer to dry.

Pectin Bioplastic: You may have heard of pectin before and might even have made some while making jams. Pectin is a colorless powder typically obtained from fruit. It is a polysaccharide starch found in the cell walls of fruits, vegetables, and plants - it is the second most abundant component of the cell wall of all land plants. Pectin functions as the polymer in bioplastic mixtures and is what makes jams jelly!

Pectin is often used as a gelling agent in desserts, but it also has wide applications in various fields due to its use as a gelling, emulsifying or stabilizing agent and its non-toxic, bio-compatible, and biodegradable nature.

In terms of biomaterials, pectin can have different applications, including food packaging, pharmaceutics, nutraceuticals, drug delivery, tissue engineering, and cosmetics.

The properties of pectin can be improved and modified with bio-fillers or in a mixture of other gelling ingredients (polymers). For example, adding a bio-filter like peels can help keep your bioplastic shape and reduce shrinkage.

Petri dish: A petri dish is a small plastic container. It is usually used to culture (grow) microorganisms in a controlled environment but can also be used as molds for material science experiments like you just did. Petri dishes come in several sizes, including 6 cm and 10 cm. They are sometimes called "plates."

Polymers: Plastics are chains of repeating molecules linked together called polymers. Whether natural or artificial, polymers are long molecules made by linking up smaller repeating molecules. Wool, cotton, and silk are natural polymer-based materials. Cellulose, the main component of wood and paper, is also a natural polymer, as are the starch molecules made by plants. Learn more about polymers here: https://www.sciencenewsforstudents.org/article/explainer-what-are-polymers

Shrinking: See drying.

Starch: is a white flour-like powder typically obtained from corn or potatoes. Starch itself is a polymer made by plants to store energy. It can be used as the polymer in your mixture or an additive to another polymer mix.

Troubleshooting

Here are some possible common issues:

My bioplastic does not solidify/gel.
When done correctly, the bioplastic will harden into a sheet. If it is not:

1. You likely did not heat (boil) the water before or after adding the ingredients

2. You might not have added all the powder from the tube, resulting in too much water vs. ingredient(s).

3. You may not have fully dissolved the powder, meaning it cannot turn into a gel and will look cloudy. You can practice by making Jell-O! Next time heat and swirl longer to ensure the powder is fully dissolved.

My bioplastic breaks:
Don't worry; some of the bioplastics recipes give thin, brittle plastic sheets. If your sheet or sample breaks, you can:

1. Melt it back down! Go back to the recipe and add the same amount of water to your mixing bowl! Add your broken plastic sheet and microwave until boiling. Stir and pour into an oiled mold. Note that bioplastics are hard to melt back down. Try the method below to repair them instead. Note that trying to melt the biocomposites might not work depending on the filler you used.

2. You can repair most bioplastics by dipping or coating the two edges of the break with boiled water and then pressing the edges together again. Leave to dry.

If anything else causes you issues, please contact us : help@amino.bio

More Information

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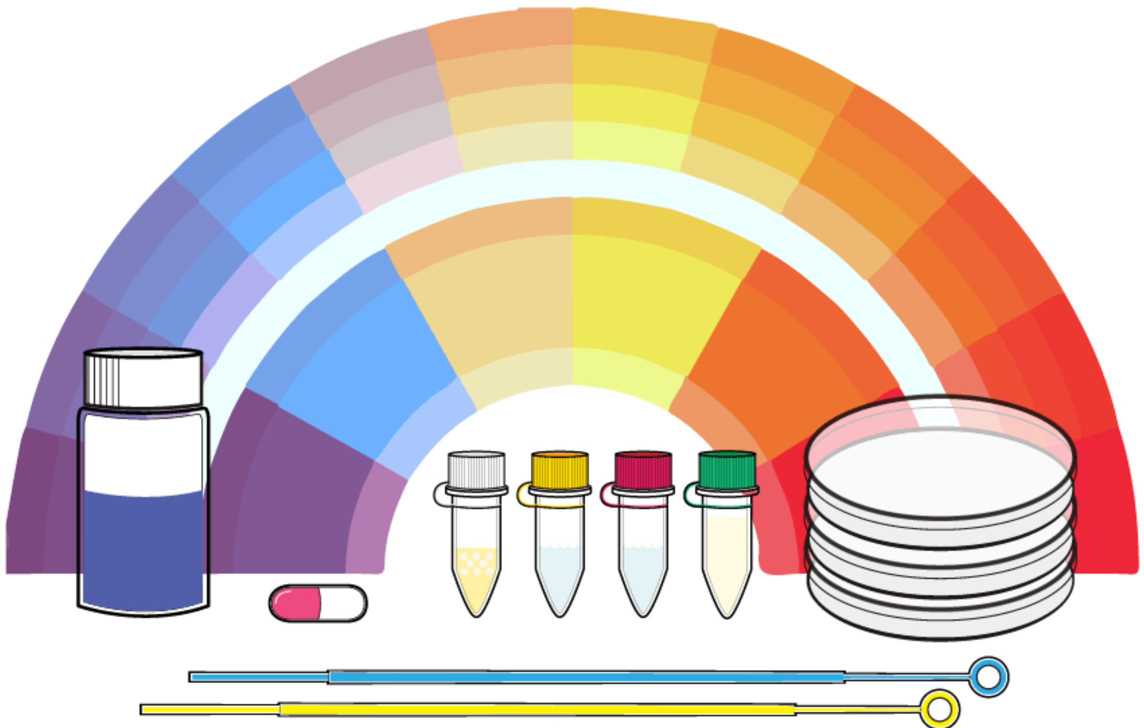

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