BIOPLASTICS KIT BETA

EXTRUDE STRINGS & SEQUINS




www.amino.bio

Version 5.1, July 2023

BIOPLASTICS KIT™
EXTRUDE STRINGS & SEQUINS
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.**

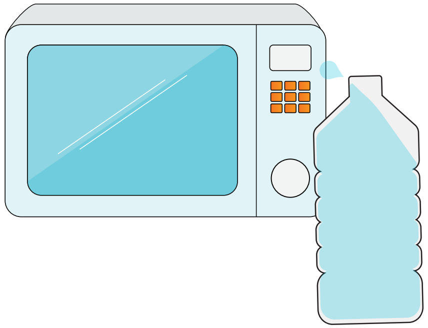
While these also include rules specific to experiments with live organisms, you can still download a biosafety poster for your space from www.amino.bio/biosafetyinaction and complete a short safety quiz at www.amino.bio/biosafety-quiz

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

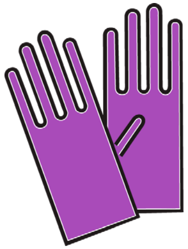
Unpacking and storing kits

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?

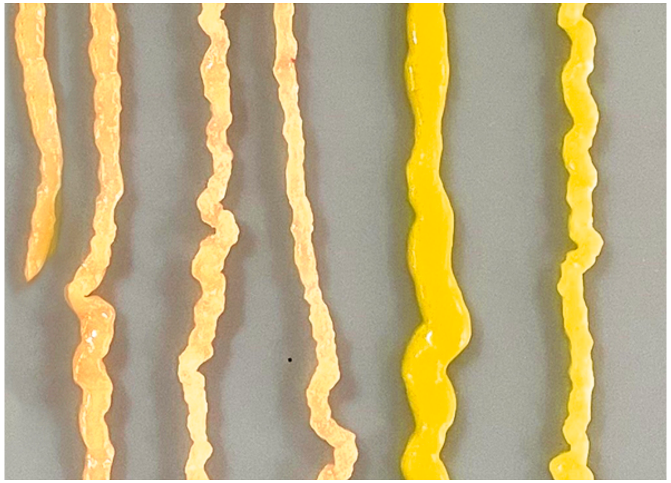
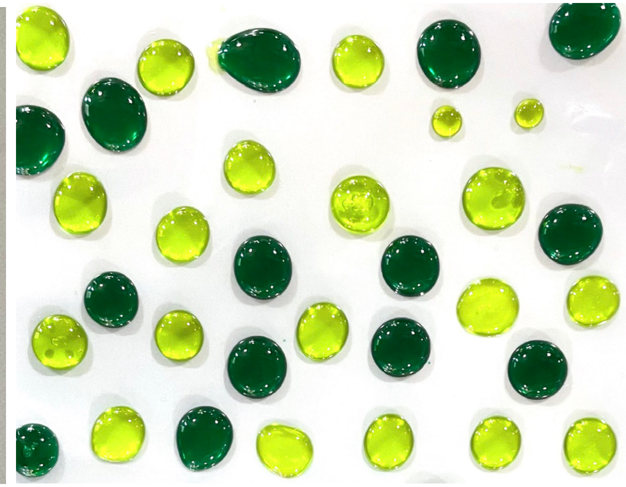
These new types of plastics made with biological-based ingredients are called bioplastics. And early research indicates that they could be a significant improvement over petroleum-based plastics. To be specific, bioplastics are plastics made at least in part with renewable biological matter (like vegetable 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 be able to explore two different ways of extruding bioplastics. Using the same base bioplastic reci-pe, you'll extrude strings with different concentrations of gelatine or glycerol to change how stretchy they are, and you'll also create sequins of different colors. 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 and see first-hand how they affect the results: gelatin, glycerol, and water
- gain or improve your making skills like mixing, measuring, and extruding bioplastics.
- create biodegradable sequins and strings you can use as you wish!

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.

Pipette: While disposable, this plastic pipette can be easily rinsed and reused to create bioplastic sequins.

Syringes : Two syringes with the plastic caps used to extrude strings of bioplastics.

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).

Optional: 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. With yellow, blue and red dyes you will be able to create all colors.

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. Once dry, you can use your strings and sequins to create or decorate items. Done with them? Melt them down! 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 Kit:
Extrude strings & sequins →

Day 1

Mix bioplastic ingredients & extrude them into strings using syringes or into sequins using a plastic pipette (50 minutes)

Drying time
(~24-48 hours)

Day 2 (optional)

Use your strings to make braids, weaves, bracelets, to decorate and more. You can also use your sequins to decorate.

Extrude bioplastic
Use syringes and pipettes to extrude bioplastic into strings and sequins:

- **Day 1, 50 minutes**
- **Dry time 24-48 hrs**
- **Optional 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. Make bioplastic strings and sequins

Goal **Reinforce your bioplastics by reusing waste**

Materials from your kit
1x tube of oil
2x bag of gelatin (1 g)
1x bag of gelatin (3 g)
2x tube of glycerol (1mL)
1x tube of glycerol (2mL)
Dye bag
1x Plastic pipette
2x syringes with caps
Beaker or mixing bowl
Plastic bag from your kit

Materials you provide
1x Mixing utensil
1x teaspoon or tablespoon to measure water
~45 mL Water (15 mL per recipe)
Microwave, Paper towels
Scissors

Today, you'll learn how to extrude bioplastic strings and sequins using syringes and a pipette. You'll make 3 recipes of bioplastic and use your food dye to color code them.

By modifying the concentration of ingredients in your recipes, you'll get strings with different properties, from stretchy to rigid. You'll also use time to modify their properties: by extruding some strings right away, and extruding some after waiting for the bioplastic to solidify, you'll get different shapes of strings, from flat to circular.

Sequins are small, shiny circle usually made of metal or plastic that are typically used for fast fashion and are quite taxing on the environment. For your sequin extrusion, you'll use all of the different bioplastics to get a variety of sequins, and see if they could be used in the real world.

Prepare

3.1. Take the bag your kit came in, and cut along the two sides so that you end up with a flat, long rectangle of plastic. This will be your extrusion surface. If you discarded your bag, you can use any plastic bag you have available, or a piece of wax paper or aluminium paper.

3.2. Take a paper towel and did it in your tube of oil. Lightly coat the side of the plastic you will extrude on in order to prevent and sticking of the bioplastic on the plastic.

Make your first bioplastic recipe

This bioplastic will have an equal concentration of gelatin and glycerol in it.

3.3. Using a spoon, measure **~15 ml** of water (1 tablespoon or 3 teaspoons) and add it to your beaker. Microwave it for 60 seconds, or until it reaches a rolling boil.

Note: If you don't have a teaspoon/tablespoon, you can use your beaker to measure the water. The first line on your beaker on the mL side is for 25 mL, so if you fill the beaker halfway to that mark, you will get ~12.5 mL of water, which is close enough for this exercice.

3.4. Add one tube of glycerol (**1 mL**) and one packet of gelatin (**1 g**) to the water in the beaker. Stir until roughly combined–it's okay if there are some clumps.

3.5. Microwave the mixture for 10 seconds at a time until you see it foams. Watch the mixture carefully to ensure that it does not boil or foam over the edge of your bowl. The bioplastic should be relatively clear but may have bubbles. If clumps persists microwave for five more seconds and stir. Repeat until smooth.

3.6. Add 1 drop of red dye to the bioplastic mixture. Stir with your mixing utensil until the color is even.

Extrude your red strings

3.7. You will use one of the syringe to extrude long strands on your plastic surface. Take one of the syringes and remove the colored cap by twisting it off. Set the cap to the side for now.

3.8. Fill the syringe with bioplastic from the beaker.

3.9. If there is any air in your syringe, remove it by pointing the end of the syringe to the ceiling and gently pressing on the plunger until all the air in the syringe comes out. Go slowly to avoid mess!

3.10. Place the end of the syringe at the top of the plastic surface and extrude a string by applying gentle, even pressure on the plunger with your thumb as you drag the end of the syringe slowly on the surface of your plastic bag. Note: Go SLOW! If you press too hard on the plunger, the material will extrude too quickly and create a pool of liquid, rather than thin strands.

3.11. Continue to make strands of bioplastic until you have used up all the red bioplastic in your syringe. Make the strings as long as you can, but keep them close together on the surface since you will need the space for 5 different strings on the surface.

TROUBLESHOOTING: Your mixture may extrude unevenly if you press too hard or too fast on the plunger and/or if there are air bubbles in your mixture. If this happens, you can: remove the plunger from the syringe and use your mixing utensil to scoop up the mixture back into the syringe. Then, place your syringe upright into a microwave-safe container like your beaker and microwave for 5 seconds. Try extruding again!

Extrude your red sequins

3.12. Use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface. Try to create rounded drops of 5 to 10 mm, leaving at least half a centimeter between each drop.

3.13. Repeat pipetting the sequins on the surface until you have about 5 mL- 8mL of bioplastic left in your beaker (half of what you started with!).

3.14. After you have made all your sequins, rinse your pipette by pipetting hot tap water up and down. Repeat until no visible residue remains.

Prepare to your purple bioplastic

For these strings, you will add the bioplastic to your syringe and wait ~30 minutes before extruding it

3.15. Add 1 drop of blue dye to the remaining red bioplastic in your beaker and mix to make purple. If needed, you can microwave to liquify the bioplastic to mix the color in.

3.16. Take the same syringe as before and draw up the purple bioplastic mixture until the syringe is full, about 4 mL.

3.17. Remove the air from the syringe as you did before and place the colored cap back on the syringe.

3.18. Make note of the time, or start a 30 minute timer. You will continue on with the experiment and extrude your purple sequins while you wait.

Note: If you want to speed up the experiment, you can place the syringe in a refrigerator or freezer, but be sure to check back often on your syringe as you do not want the mixture to solidify too much. If it does won't be able to extrude at all! If this happens, place the syringe in a microwave safe container and heat up 2-3 seconds at a time until the mixture is liquid again. Then, restart your timer and wait until the mixture solidifies to a jelly-like consistency.

Extrude your purple sequins

3.19. You'll once again use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface. Try to create rounded drops of 5 to 10 mm, leaving at least half a centimeter between each drop.

3.20. Repeat pipetting the sequins on the surface until you have enough sequins or no more bioplastic.

3.21. After you have made all your sequins, rinse your pipette by pipetting hot tap water up and down. Repeat until no visible residue remains. You can also wash your beaker and mixing utensil with hot water before moving onto the next step.

Extrude your purple strings

3.22. After 30 minutes, you will extrude purple strings using the same syringe method as above. The difference will be in the way the string holds its shape as you extrude it.

How do I know if I am ready to extrude after the 30 minute wait?

3.23. When ready to extrude, the mixture in the syringe should not flow like a liquid when you move the syringe, and the syringe should not be warm to the touch. If you start extruding the strings and the mixture flows like a liquid, wait longer.

3.24. To verify if you are ready start extruding the string on the plastic surface to create a string of ~1 cm. Is it jelly-like and holding its shape? Perfect. You are ready to extrude. If not, let the mixture sit longer.

Make your second bioplastic recipe

This bioplastic will have a higher concentration of gelatin in it.

3.25. Using a spoon, measure ~**15 ml** of water (1 tablespoon or 3 teaspoons) and add it to your beaker. Microwave it for 60 seconds, or until it reaches a rolling boil.

3.26. Add one tube of glycerol (**1 mL**) and one packet of gelatin (**3 g**) to the water in the beaker. Stir until roughly combined–it's okay if there are some clumps.

3.27. Microwave the mixture for 10 seconds at a time until you see it foams. Watch the mixture carefully to ensure that it does not boil or foam over the edge of your bowl. The bioplastic should be relatively clear but may have bubbles. If clumps persists microwave for five more seconds and stir. Repeat until smooth.

3.28. Add 1 drop of blue dye to the bioplastic mixture. Stir with your mixing utensil until the color is even.

Extrude your blue strings

3.29. You will use your other syringe to extrude long strands on your plastic surface. Remove the colored cap by twisting it off. Set the cap to the side for now.

3.30. Fill the syringe with bioplastic from the beaker. If there is any air in your syringe, remove it like you did before. Remember to go slowly to avoid mess!

3.31. Just like before, place the end of the syringe at the top of your extrusion surface and extrude a string by applying gentle, even pressure on the plunger with your thumb as you drag the end of the syringe slowly on the surface of the plastic surface until you reach the bottom edge.

Note: Remember to go SLOWLY! If you press too hard on the plunger, the material will extrude too quickly and create a pool of liquid, rather than thin strands.

3.32. Continue to make strands of bioplastic until you have used up all the yellow bioplastic in your syringe.

Extrude your blue sequins

3.33. Time for the blue sequins! Like before, use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface. Try to keep their size consistent if you can.

3.34. Repeat pipetting the sequins until you have about 5 mL- 8mL of bioplastic left in your beaker. Then, rinse your pipette by pipetting hot tap water up and down.

Prepare to your green bioplastic

For these strings, you will add the bioplastic to your syringe and wait ~30 minutes before extruding it

3.35. Add 3 drops of yellow dye to the remaining blue bioplastic in your beaker and mix to make green. You can microwave again if needed.

3.36. Take the same syringe as before and draw up the green bioplastic mixture until the syringe is full, about 4 mL.

3.37. Remove the air from the syringe as you did before and place the colored cap back on the syringe.

3.38. Make note of the time, or start a 30 minute timer. You will continue on with the experiment and extrude your green sequins while you wait. If you want, you can also place the syringe in the freezer or refrigerator to speed up the solidifying process.

Extrude your green sequins

3.39. You'll once again use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface, repeating until you have used up all your remaining bioplastic from the beaker.

3.40. Rinse your pipette by pipetting hot tap water up and down and wash your beaker and mixing instrument before moving onto the next step.

Extrude your green strings

3.41. After 30 minutes, you will extrude purple strings using the same syringe method as above. The difference will be in the way the string holds its shape as you extrude it. You'll know you are ready to extrude just like you did before, by making sure the syringe is not warm to the touch, and if the first ~1 cm of string is jelly-like and holding its shape? If not, let the mixture sit longer.

Make your third (and last) bioplastic recipe

This bioplastic will have a higher concentration of glycerol in it.

3.42. Using a spoon, measure ~**15 ml** of water (1 tablespoon or 3 teaspoons) and add it to your beaker. Microwave it for 60 seconds, or until it reaches a rolling boil.

3.43. Add one tube of glycerol (**2 mL**) and one packet of gelatin (**1 g**) to the water in the beaker. Stir until roughly combined–it's okay if there are some clumps.

3.44. Microwave the mixture for 10 seconds at a time until you see it foam. Mix and microwave until it is smooth.

3.45. Add 3 drops of yellow dye to the bioplastic mixture. Stir with your mixing utensil until the color is even.

Extrude your yellow strings

3.46. You will use your other syringe to extrude long strands on your plastic surface. Remove the colored cap by twisting it off. Set the cap to the side for now.

3.47. Fill the syringe with bioplastic from the beaker. If there is any air in your syringe, remove it like you did before. Remember to go slowly to avoid mess!

3.48. Just like before, place the end of the syringe at the top of your extrusion surface and extrude a string by applying gentle, even pressure on the plunger with your thumb as you drag the end of the syringe slowly on the surface of the plastic surface until you reach the bottom edge.

3.49. Continue to make strands of bioplastic until you have used up all the yellow bioplastic in your syringe.

Extrude your yellow sequins

3.50. Time for the yellow sequins! Like before, use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface. Try to keep their size consistent if you can.

3.51. Repeat pipetting the sequins until you have about 5 mL- 8mL of bioplastic left in your beaker. Then, rinse your pipette by pipetting hot tap water up and down.

Prepare to your orange bioplastic

For these strings, you will add the bioplastic to your syringe and wait ~30 minutes before extruding it

3.52. Add 1 drop of red dye to the remaining yellow bioplastic in your beaker and mix. If needed, you can microwave to liquify the bioplastic to mix the color in.

3.53. Take the same syringe as before and draw up the green bioplastic mixture until the syringe is full, about 4 mL.

3.54. Remove the air from the syringe as you did before and place the colored cap back on the syringe.

3.55. Make note of the time, or start a 30 minute timer. You will continue on with the experiment and extrude your orange sequins while you wait. If you want, you can also place the syringe in the freezer or refrigerator to speed up the solidifying process.

Extrude your orange sequins

3.56. You'll once again use the plastic pipette to suction up some bioplastic mixture from your mixing petri dish and gently pipette out small drops of bioplastics on your plastic surface, repeating until you have used up all your remaining bioplastic from the beaker.

3.57. Rinse your pipette by pipetting hot tap water up and down and wash your beaker and mixing instrument. Leave them to dry

Extrude your orange strings

3.58. After 30 minutes, you will extrude purple strings using the same syringe method as above. The difference will be in the way the string holds its shape as you extrude it. You'll know you are ready to extrude just like you did before, by making sure the syringe is not warm to the touch, and if the first ~1 cm of string is jelly-like and holding its shape? If not, let the mixture sit longer.

3.59. Rinse out your syringes and caps with hot water. Leave them to try with your beaker, pipette and mixing instruments. You can reuse these to make more bioplastics in the future.

Drying and viewing all your results

3.60. Let all your strings and sequins fully dry at room temperature for ~ 24 hours, or until they are no longer sticky to the touch. If you can, placing them in a hot room can cut down on the drying time.

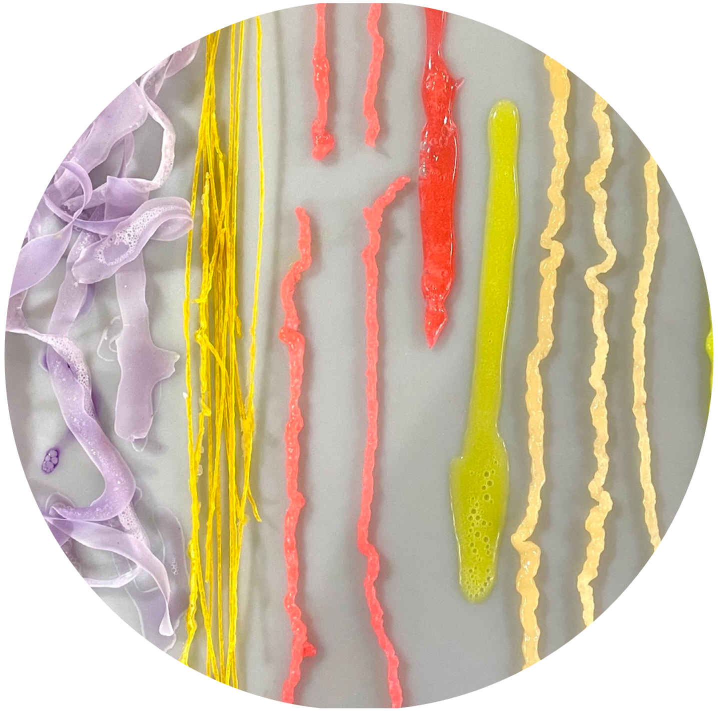
3.61. Once your bioplastics are dry (no longer gel-like to the touch), un-stick them from the extrusion surfac by slowly and gently peeling them up.

Learn from your experiment and use your results

3.62. What differences are there between the bioplastics? Look at each color of string and sequins - did the concentration of glycerol or gelatin impact how they behave? If you'd like to evaluate their different properties, use this google document: https://amino.bio /bioplastic-strings-analysis

3.63. Now that you have strings and sequins of all types you can use them to decorate other bioplastic creations, and to weave, braid, and get creative.

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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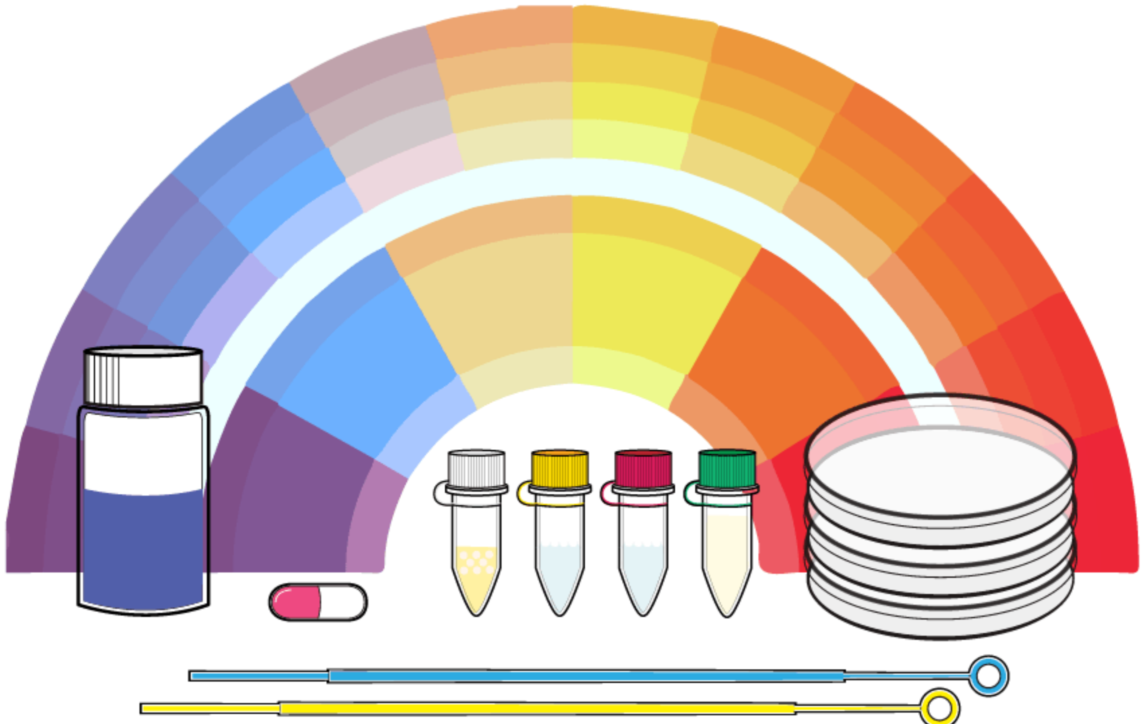
All Amino Labs products, from the hardware to the DNA, are invented, designed, manufactured and shipped by us, in our laboratory- workshop in Canada and we'd love to hear your feedback and suggestions to continue to make our products better and fitting to your needs. Answers to your questions and help are also just an email away.

Help and General inquiries: help@amino.bio
Feedback, Suggestions, Comments: info@amino.bio



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