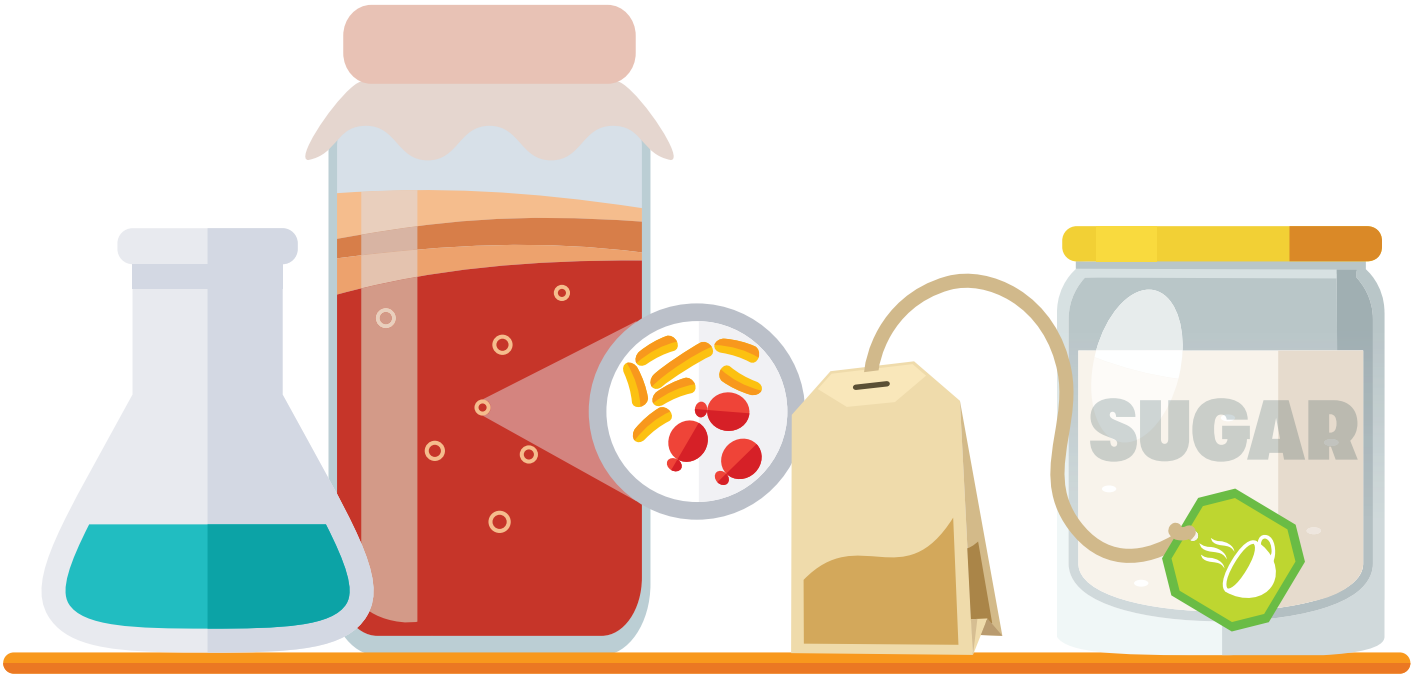
The Tech Interactive at Home

Making with Microbes

Who says all the fun has to happen at The Tech Interactive? This DIY biotinkering activity can be done with inexpensive store-bought supplies and things you find around the house!



Introduction

Ever wanted to make your own paper or plastic? Or create leather that doesn't use animals? Why not try collaborating with microbes — tiny microscopic organisms — to design and grow a custom biomaterial at home! This biomaterial is made by the millions of living yeast and bacteria that normally work together to produce kombucha, a fermented tea. But, depending on what you feed your collaborators, they can also grow interesting and different pieces of biomaterial for you!

Design Challenge

Grow your own unique piece of biomaterial and make something creative with it!

Subject:
Biology, Biodesign

Age:
8+

Time:
Mix: 30-45 min
Grow: 7+ days
Dry: 1-2 days
Create: 30 min

Key Concepts:
Living systems, biomaterials, microbes, fermentation

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Materials

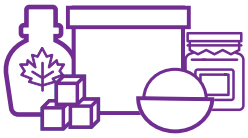
You will need a **bottle of store-bought kombucha tea** — this is your source of living microbes! Look for an unflavored bottle, as some flavored varieties won't grow very well, but you can try any type in a pinch.

In addition you will need the **food ingredients** to feed your microbes and the **equipment** to grow them in. There are a variety of ways you can experiment with these materials to customize your biomaterial. Here are a few suggestions. Use whatever you have on hand — be creative!

Microbe Food

Sugar Sources

- White sugar
- Agave syrup
- Brown sugar
- Molasses
- Maple syrup



Tea Types

- Black
- Green
- Oolong
- White

Do not use

- Honey (grows bad bacteria)
- Splenda (microbes can't eat this)
- Flavored teas (e.g., Earl Grey)
- Herbal teas

Equipment

Growth Containers

- Tupperware
- Plastic tubs
- Glass jars
- Bowls
- Cups

Growth Container Covers

- Coffee filter
- Clean cloth
- Paper towel
- Lid with holes punched in it

Drying surfaces

- Plastic wrap
- Place mat
- Wax paper
- Baking mat
- Bendy plastic

Do not use

- Metal (will corrode)
- Airtight lid (microbes need oxygen to live)
- Rigid or metal surface (difficult to remove)

Instructions

Step 1. Mix food for your microbes (30-45 min)
First, you need to choose what you will feed the living bacteria and yeast in your store-bought kombucha tea. Different ingredients and new food mixtures will create unique pieces of biomaterial!

Use our starter recipe below for the base of your microbe food:

Hot water	2-4 cups
Sugar (any source)	2-4 tsp.
Tea (any type)	1-2 bags (or 2-4 tsp. loose leaf)
Kombucha tea	2-4 cups

1. Boil some water. Ask an adult for help!
2. Add your sugar source(s) and mix until dissolved.
3. Add your tea(s) and steep for 5-10 min.
4. Let your food mixture cool to room temperature. You can put it in the fridge to speed this up!

IMPORTANT! Make sure your mixture has cooled to room temperature before adding in your kombucha tea. Food that is too hot to touch for 10 seconds will kill your microbes!

5. Combine your cooled microbe food and kombucha tea in a clean growth container. You'll want a mixture of about ½ kombucha and ½ microbe food.
6. Cover the growth container with something that lets air in but keeps insects out. Keep it in place with a rubber band or tape, if needed.

Step 2. Grow your biomaterial (7+ days)
1. Set your growth container in a place that doesn't get too hot or too cold. Remember, your microbes are alive, so a cozy temperature will help them work faster!
2. After a few days, you should start to see a thin layer of biomaterial forming on the surface, so try not to move your growth container.
3. Leave your culture growing for about a week, or until it grows biomaterial that is at least 1-2 mm thick. You can let it grow longer if you want — the biomaterial will keep getting thicker until the microbes eat up all the sugar.

Natural Odors: Don't be surprised if your culture starts to smell a bit as it grows — that's completely normal and the vinegary odor means your microbes are hard at work!

Microbe Care Tips!

Taking care of microbes is kind of like getting a new pet — you'll need to feed them, but you don't know what food they like best! So, we recommend feeding them a variety of different types of sugar and tea the first time you try to grow biomaterial. This will help make your microbes comfortable and strong.

There are two ways you can go about this:

1 Make some microbe food that combines multiple teas and sugar types in one batch. That way, your microbes are sure to find something they like to eat, so they can get to work right away.

2 Start a few small growth containers at the same time, each with a different sugar or tea. This will increase your chances of success and help you learn what your microbes like best.

Step 3. Dry your biomaterial (1-2 days)

- Remove your grown biomaterial from the growth container. It will be wet and floppy!
- Lay it out flat on a surface to dry. Want to add 3D patterns or textures? Lay out your biomaterial on something bendy, like plastic or silicone, that has a cool pattern.
- You can use a fan or the sun to speed the drying process.

Step 4. Create something! (30 min)

- When your biomaterial is fully dry, carefully peel it off of the drying surface.
- All biomaterial is unique, so consider the properties of your specific piece as you decide what to make with it. Is it thick or thin? Brittle or flexible? Sticky or not-so-sticky?
- Some properties might make it the perfect material for folding an origami creature or braiding a bracelet. Other qualities might mean it would be better to turn into a gift tag, wallet, or some colorful window art. It's entirely up to you!

Explore More

Now that you have fully woken up your microbes and they are happy and strong, you can challenge them to do more complex things! They will continue growing pieces of biomaterial as long as you give them new food. So, repeat the steps above, but use liquid from your growth container (which has lots of microbes) instead of a store-bought kombucha tea.

Design and grow some biomaterial that has your desired look, feel, and personal flair. Some bonus challenges to explore include:

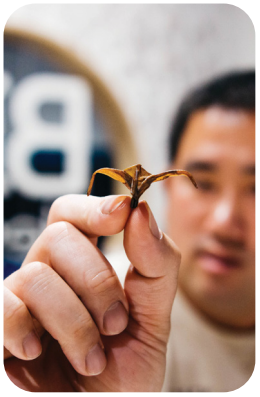
- **Shape** — can you use different growth containers to make new and interesting shapes?
- **Color** — can you add food coloring or dyes to make your favorite color?
- **Feel** — can you achieve a desired feel with different combinations and types of tea and sugar?
- **Smell** — can you change the smell by mixing different food or adding something during drying?

The Science of Fermentation

In kombucha tea, yeast and bacteria work together to ferment the sweet tea — they actually need each other to thrive. The yeast get the whole process rolling by eating the sugar molecules in sweet tea and producing alcohols. This generates CO_2 gas, causing many bubbles to appear. Next, it's time for the bacteria to get involved. They eat the alcohols made by the yeast and turn them into acids. This is what makes your culture smell a bit like vinegar. As fermentation progresses, the tea gets more and more acidic, which makes it hard for other microbes to invade and steal their food. You can see why these microbes are such a good team!

What is this biomaterial made of?

Our biomaterial is made of microbial cellulose, which is similar to what helps plants stand upright. It is produced by the bacteria that live in kombucha tea.



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