EXPERIMENT MANUAL

Tasty Labs

Space Gummy Candy Lab

THAMES & KOSMOS

WARNING. Only for use by children 6 years of age or older with continuous adult supervision and assistance. Adult supervision required at all times. Use of a microwave or stove is required. Hot mixtures and stove tops can cause severe burns.

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Safety information

Warning! Not suitable for children under 6 years. For use under adult supervision. Read the instructions before use, follow them and keep them for reference.
Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 6 years old.
Warning. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled.
Keep the packaging and instructions as they contain important information.
The gummy pieces should be wrapped in the plastic bags before labeling them with the stickers.
All of the plastic parts should be cleaned by hand before use.

Ingredients

Sugar, Gelatin, Citric Acid, Natural and Artificial Flavors, Colors (Yellow 5, Red 40, Blue 1, Titanium Dioxide).

Safety rules

Read this before starting any experiments.

1. Read these instructions before use, follow them and keep them for reference.
2. Keep young children and animals away from the work area and stove at all times.
3. Store this kit out of reach of children under 6 years of age.
4. Clean all equipment after use. Clean all pots and utensils with hot water and soap.
5. Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
6. Never work alone. An adult should always be present. Pay attention to the information provided with each experiment.
7. Pay special attention to the quantity specifications and the sequence of the individual steps. Only perform experiments that are described in this instruction manual.
8. The included plastic mold for the gummy shapes is not dishwasher safe. It will be deformed by high temperatures, so wash it by hand.
9. Clean the work surface carefully after you are finished and always wash your hands thoroughly — before and after you work.
10. If you are allergic to certain foods you must avoid sweets that contain such ingredients. Therefore, always begin by checking the list of ingredients. If you are diabetic, you must only eat the amount of sugar allowed by your diet plan.
11. It goes without saying that there can be no smoking in a confectionery shop.

Advice for parents and supervising adults

This experiment kit is not suitable for children under 6 years. It must be used with an adult at all times. The kit provides a fun introduction to physical science topics through gummy candy making activities and experiments.

The work of a candy maker is fun and exciting, but it is not always easy. This is why we would like to thoroughly inform you of safety precautions, so that you can guide your child with advice and help. You must supervise and assist them with all of the activities in this kit, but especially when using the stove, microwave, and working with hot ingredients. This also applies to the use of sharp knives and other kitchen utensils (e.g. breakable glasses).

Take a look through this instruction manual and pay particular attention to the:

→ Safety information and rules (inside front cover),
→ Safety notes that accompany each experiment (marked with an exclamation point symbol), and
→ First aid in case of accidents (inside back cover).

Discuss the experiments and the individual work steps with your child before beginning. Use only the recommended ingredients.

Candy making requires several different talents and skills. It can be affected by the weather, temperature, and the specific equipment used. Don't get discouraged if a particular step does not work out as expected. Having some experiments "fail" is an important part of science.

Select the working steps that appear suitable for your child and supervise them during the melting, pouring, packaging, and storage of the gummy candies. Your own gummy shapes will not keep as long as commercially available gummies, which often contain preservatives. Write the production date on the packaging and store in the refrigerator. Make sure that the candies are consumed within one week after they are made.

Tell your child to read these instructions, safety rules, and first aid information, to follow them, to keep them for reference, and to perform only those experiments that are described in the manual.

Pick an area in the kitchen that can tolerate spills and stains. When working with hot pots, have a trivet and pot holders available, and make your child aware of the danger of burns.

To keep the plastic mold tray in good condition, always wash it by hand and not in the dishwasher. The high temperatures used in a dishwasher might deform the plastic tray.

If your child has to stay away from certain sweets or avoid some ingredients (for example because of an allergy), you will have to alter the recipe or not use it. Always check the contents of purchased ingredients.

We hope you and your young candy maker have lots of fun with this kit!

NOTE! *The additionally required items are highlighted in italic script in the individual experiments. Before starting the experiments, carefully read through everything that will be required and make sure to have all the materials ready.*

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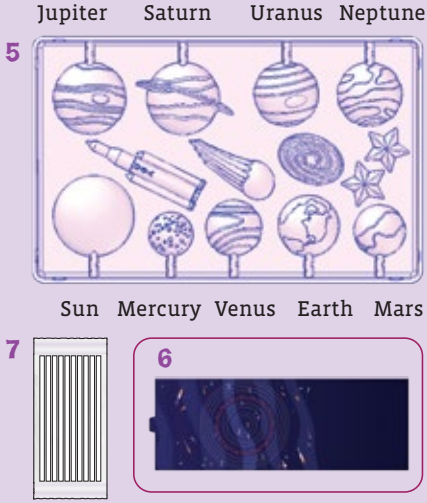
KIT CONTENTS



1	Strawberry (red) gummy candy mix (Net Wt. 40 g/1.41 oz)
2	Blueberry (blue) gummy candy mix (Net Wt. 40 g/1.41 oz)
3	Pineapple (yellow) gummy candy mix (Net Wt. 40 g/1.41 oz)
4	Coconut (white) gummy candy mix (Net Wt. 20 g/0.71 oz)
5	Plastic gummy candy mold
6	Cardboard solar system display
7	Lollipop sticks (x10)

TO MAKE THE GUMMIES, YOU WILL ALSO NEED: *Scissors, tablespoon, teaspoon, water, small bowl, spoon, toothpick or fork, plate, refrigerator*
FOR SOME EXPERIMENTS, YOU WILL ALSO NEED: *Drinking glass or jar, measuring cup, tablespoon and teaspoon, microwave-safe plates, microwave, paper cups*

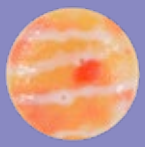
Hey Gummy Scientists!

Want to make yummy gummy candy treats in the shapes that are out of this world — *and* learn some physical science and fun space facts while you're at it? Then let's get started! After you've made your gummy shapes, you can place them in the cardboard display and see a model of our solar system. Then you can give them to your family and friends! Gumbi the Geeker will be your guide!

PART 1

MAKE YOUR OWN GUMMY CANDIES

With this kit, you can make:


Jupiter

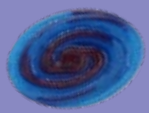

Saturn


Uranus


Neptune


Rocket


Comet


Galaxy


Stars


Sun


Mercury


Venus


Earth


Mars

Note: These gummies will not turn out exactly the same as commercial store-bought gummies. See pages 12–13 to learn about different gels.

- **Read all of the instructions carefully before starting.**
- **Follow the instructions precisely.**

Safety Note:
Caution! Hot water is used. Be careful when handling hot water.

General Instructions:

1. Combine **3 parts** gummy mix with **4 parts** hot tap water and mix thoroughly. For example, mix **1 tablespoon** (= 3 teaspoons) of gummy mix with **1 tablespoon plus 1 teaspoon** (= 4 teaspoons) of hot water. Use level spoonfuls and do not pack the powder when taking your measurements. Use the hottest water you can get from your faucet. You could also heat up water in a microwave. Do not use boiling water.
2. Once mixed, pour or spoon the gummy mixture into the molds. Let it sit until the gummies are firm. You can put the mold tray in the refrigerator to make them firm up faster.
3. If your gummy mixture begins to solidify while you are working, you can heat it up in the microwave in 5-second bursts until it is liquid again.

See next page for detailed steps →

1. Making the solar system gummies

You will need:

- **1 Tablespoon strawberry gummy mix**
- **1 Tablespoon blueberry gummy mix**
- **1 Tablespoon pineapple gummy mix**
- **1 Tablespoon coconut gummy mix**
- **9x Lollipop sticks**
- **Space gummy candy mold**
- *Scissors*
- *Tablespoon*
- *Teaspoon*
- *Hot water*
- *Spoons or popsicle sticks*
- *4 small cups or bowls*
- *Paper cups*
- *Toothpick or fork*
- *Refrigerator*

Here's how:

1. Place the lollipop sticks into the gummy mold. Align the ends of the sticks with the center of each mold.

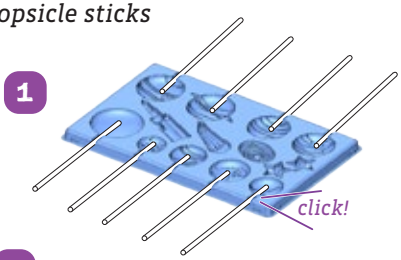
2. Use scissors to open the strawberry (red) gummy packet. Then measure **1 level tablespoon** into a small bowl or cup.

3. Turn on the hot water faucet and let the water run until it is as hot as it gets.

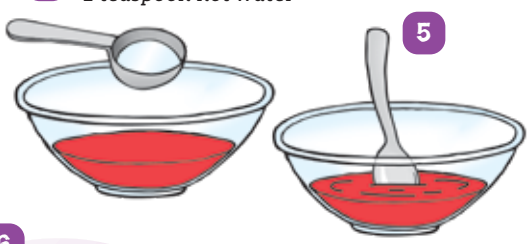
4. Pour **1 tablespoon plus 1 teaspoon of hot water** into the gummy mix.

5. Stir the mixture with a spoon or popsicle stick until the gummy mix is completely dissolved and the mixture appears smooth.

6. Repeat steps 1 – 5 with the blueberry (blue), pineapple (yellow) and coconut (white) gummy mixes.



Safety Note:
Caution! High temperatures
There is a risk of burns.



Here's how it continues:

7 Mix spoonfuls of the gummy mixes together to make even more colors. We suggest mixing colors in paper cups that are folded to have a make-shift spout, so you will be able to pour the gummy mixtures precisely. You can also use regular cups or bowls.

- ›› Red + blue = purple
- ›› Red + yellow = orange
- ›› Yellow + blue = green
- ›› Any color + white = lighter and opaque

Now you have a whole gummy color palate to play with.
If you need more of any particular color, repeat steps 1 – 5.

8 Pour or spoon the mixtures into the sun and planet molds in the tray. See the table for suggestions of color combination.

Tip: after adding one color, allow the gummy mixture to harden before adding the next color.

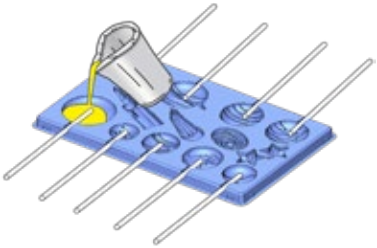
9 Optional: fill the rest of the shapes on the tray with any flavor you want.

10 Put the tray into the refrigerator and let the gummies solidify for ten to fifteen minutes.

11 After the gummies have solidified, slowly remove them from the molds by pulling the free ends of the stick upward. See next page for details on how to create the solar system model. You can also wrap finished gummies in plastic wrap.

7

8



Sun	Orange swirls, then yellow
Mercury	Purple + white
Venus	Red swirls, then orange + white
Earth	White clouds, then green + white continents, then blue
Mars	Red
Jupiter	Red dots, then white swirls, then orange + white
Saturn	White ring, then orange + white clouds, then red
Uranus	Blue + yellow + white
Neptune	Blue + white, then blue

10

until solid

Done!

11

2. Solar system model

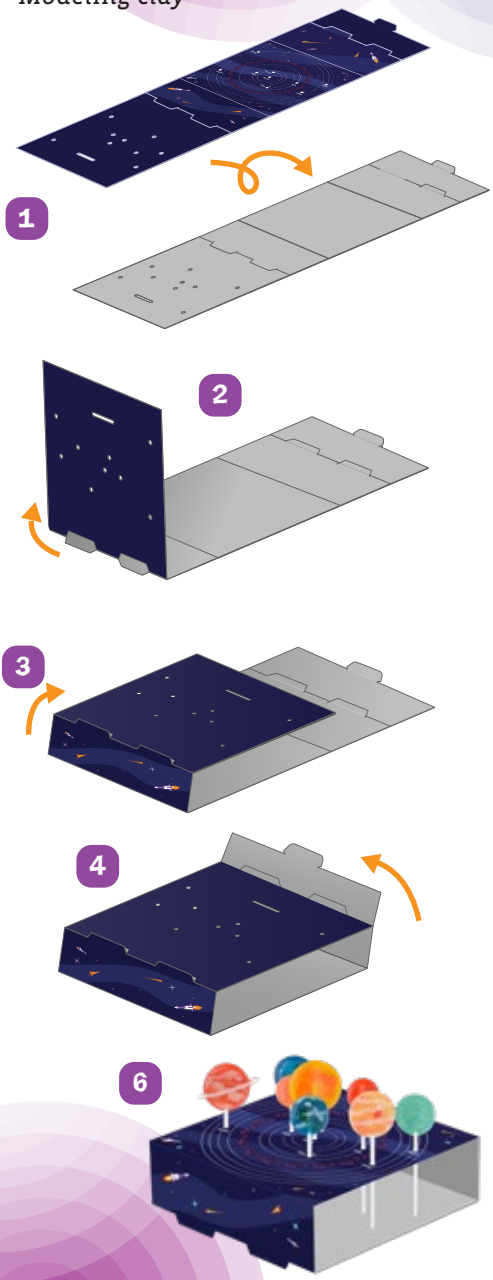
You will need:

- **The gummy lollipops you made on pages 4–5**
- **Cardboard solar system display**

Optional:
Modeling clay

Here's how:

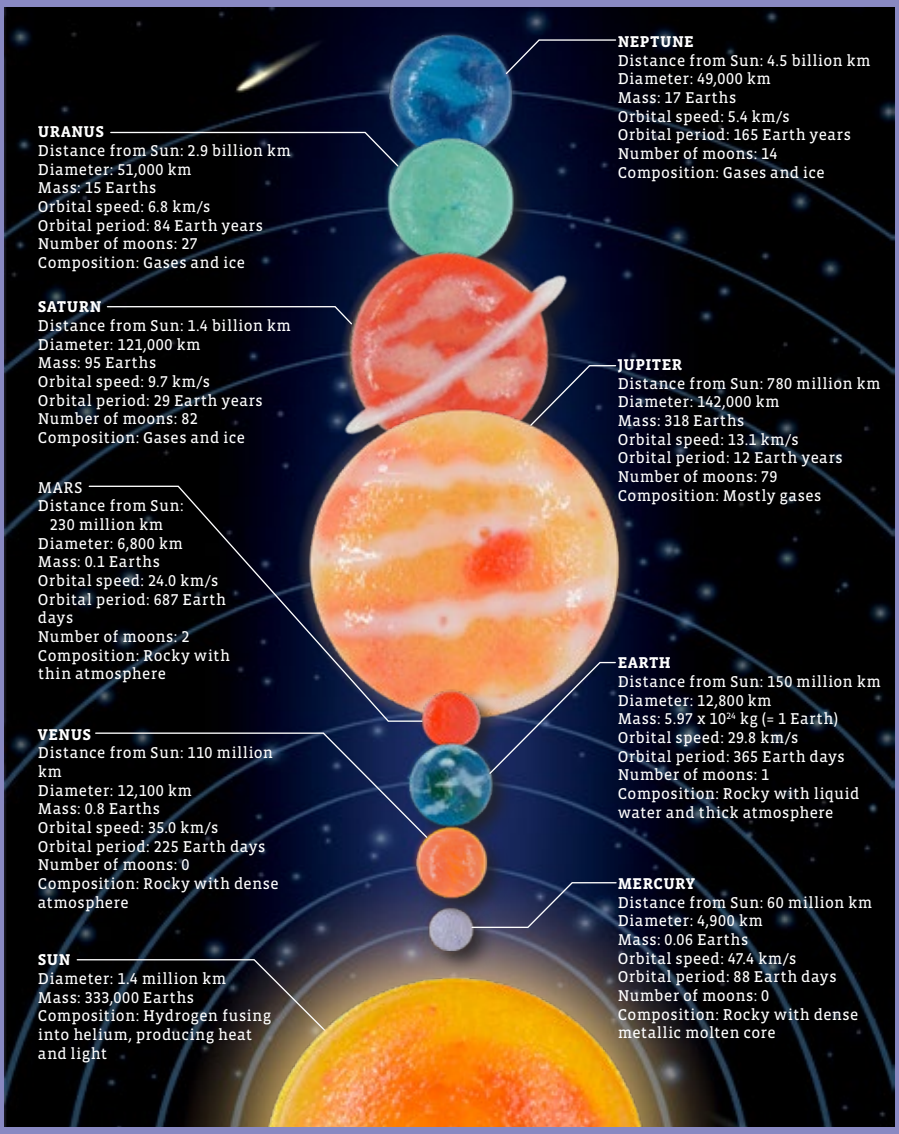
1. Flip over the solar system display to show the underside.
2. Fold along the crease bringing the lower section to a vertical position.
3. Fold the side wall up into a vertical position.
4. Fold the other side wall up into a vertical position.
5. Secure the bottom panel in place by tucking the tab into the slot.
6. Flip over the solar system display and add your gummy lollipops.
7. After you eat your gummy lollipops, you can make a non-edible, more permanent solar system display out of modeling dough.



GEEK OUT!

MEET THE PLANETS

Eight planets orbit the Sun. Each planet is moving on its own elliptical (nearly circular) path around the Sun. Each planet is a different distance from the Sun and orbits at a different speed! The planets all have different sizes, masses, and compositions.



Out of this world facts:

SPINNING SIDEWAYS

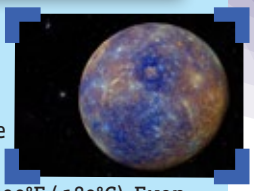
Uranus is the only planet in our solar system that spins sideways. This gives it really extreme seasons. Each hemisphere experiences winters that last for 21 Earth years! You may notice it also has rings like Saturn, but they're much harder to see from Earth.

A MULTITUDE OF MOONS

Earth only has one moon, but it's far from the only moon in the solar system. Scientists have counted 293 moons in our solar system. Mercury and Venus don't have any, and Saturn has the most at 146.

Saturn and its moon, Titan

EXTREME TEMPS



Because Mercury is so close to the sun, its surface can reach 800°F (430°C) during the day. But with no atmosphere to hold in the heat, night time temps can dip to a frigid -290°F (-180°C). Even though Mercury is closest to the sun, the record holder for heat is Venus. Its thick atmosphere keeps average surface temperatures at 870°F (465°C).

STORMY WEATHER

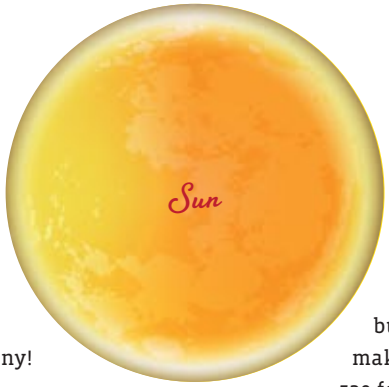
Jupiter's Great Red Spot is a giant storm that's twice as wide as Earth and 300 miles tall. Winds reach up to 400 miles an hour. This is the biggest storm on Jupiter, but the planet is covered with dozens of smaller super storms.

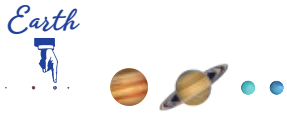
Jupiter and its moon, Europa

Let's talk about scale!

Your solar system model is a scientific model — a representation of the real thing that helps us understand some aspects of it. All scientific models are incomplete ... that's what makes them models! While your model clearly shows the order of the planets, and how the planets orbit the Sun, the model is vastly out of scale. The diameter of the Sun is more than 100 times as large as the diameter of the Earth! The size difference matters — because the Sun is so much larger than the planets, the Sun's gravity holds the planets in orbit.

Here is the Sun shown at the same size as your gummy Sun. If you made the planets to scale, they would be tiny!

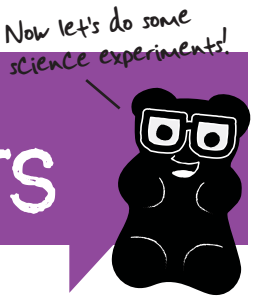




At this scale, the Earth would be about 17.7 feet away from the Sun, but we'd need a 37-page fold-out to make that fit. Neptune would be over 530 feet away. That's 1.5 football fields!

PART 2

GUMMY EXPERIMENTS



Now that you have made your gummies, do you think there is a way to remove the flavoring and sugar from the gummies while still keeping them intact?

1. Removing the color from gummies

You will need:

A gummy shape, *a drinking glass or jar, water*

Here's how:

1. Fill a glass or jar with 150 ml of water (about two-thirds of a cup) and place the gummy into the water.
   What do you think will happen to the gummy when you place it in the water?

2. Let the cup or jar sit in an out-of-the-way location for a day. Remove the gummy from the water and record what happened to the gummy on a piece of paper.

Safety Note: Do not eat the gummy candy after this experiment, because it has been sitting unrefrigerated in water for a day. As a rule, never eat or drink materials with which you conduct science experiments.

GEEK OUT!

WHAT'S HAPPENING?

From your experiment you found that leaving the gummy in water turns the gummy clear, and the coloring and sugar spread out into the water. This is because the universe has a natural tendency to go from order to disorder called **entropy.** This is why after cleaning up your room it gets messy again within a few days!

So, the colored flavoring in your gummy will spread out from inside the gummy where there is a lot of flavoring (ordered) into the water where there is no flavoring (disordered). This process is called **diffusion.**

2. Melting and freezing

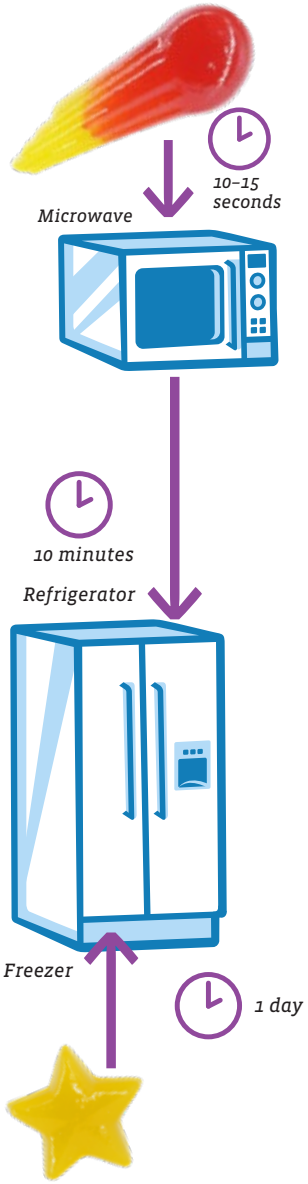
You will need:

Two gummy candies, *two microwave-safe plates*

Safety Note:
Caution! High temperatures. There is a risk of burns.

Here's how:

1. Take one of the gummies and place it on a microwave-safe plate.
2. Place the plate in the microwave for 10–15 seconds.
3. Take the plate out of the microwave. Be careful as the plate may be hot! Record your observations of what happened to the gummy.
4. Place your microwaved gummy into the refrigerator for 10 minutes. Then take it out again. Record your observations again.
5. Take the second gummy and place it on a plate.
6. Place the gummy in the freezer and let it sit there for one day.
7. Take the plate with the gummy out of the freezer. Write down your observations.
   How is the gummy able to melt and then reform into a gummy again?
   See the next page.

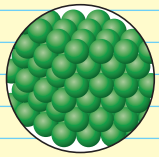


GEEK OUT!

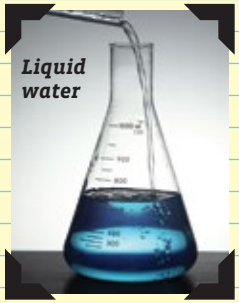
THE PHASES OF MATTER

There are three **phases of matter:** solid, liquid, and gas. (There are actually others, like plasma and Bose-Einstein condensate, but they're much less common.) This means that pretty much all the stuff you see in the world can be characterized as being in either a solid, liquid, or gas phase.

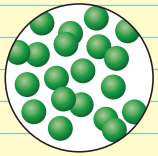
The atoms of **solids** are packed together densely and have fixed positions in space relative to each other (like bricks in a wall), which makes solids rigid.



Solid water (ice)

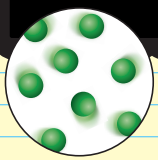


Liquid water



Liquids have atoms that are packed less densely than are those of solids, and while solids form a rigid shape, liquids move freely. But when liquids are poured into a container, they must conform to the shape of the container, except for possibly one surface (like the surface of water in a fish tank).

This is not the case for **gases,** which must conform to the shape of the container entirely (like water vapor in a fish tank, which would have no surface different from the walls of the tank). The atoms of gases are packed the least densely of all three phases, and are in relatively random motion. Gases have no definite shape or volume, can expand and contract greatly with changes in temperature and pressure, and spread easily to distribute themselves evenly throughout a container — hence their total conformity to the shapes of containers.



Gaseous water

GEEK OUT!

WHAT MAKES GUMMIES GUMMY?

How is the gummy candy mix able to form into a squishy candy when mixed with water? An ingredient called **gelatin** makes this possible. This is what makes a gummy candy gummy!

GELATIN

Gelatin is an animal protein made from bones and connective tissues. It has the ability to swell up in cold water and to dissolve when heated. And, when it cools off again, it forms a reversible **gel** — short for **gelatinous substance.** Gels contain mostly liquids, but behave more like solids. When you heat up a gel, the molecules start moving around more which lets them slide past each other more easily. This causes the gel to become more like a liquid. But when you cool the gel back down again, the molecules re-form a web-like structure and become more like a solid. A reversible gel is one that can return to an earlier state.

Gelatin contains long molecules that are made up of many repeating parts, like the links of a chain. Each molecule can also connect to other long molecules, forming a web. The general term for this type of molecule is **"polymer."** Gelatin contains a specific type of polymer called **collagen.**

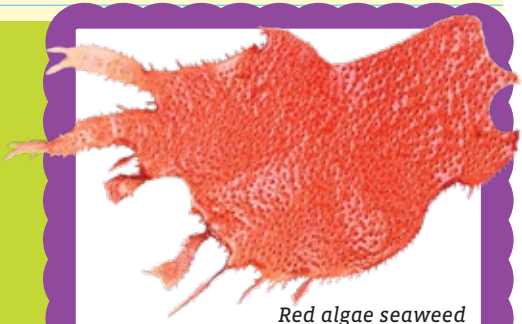
A molded gelatin dessert

One key property of this big tangled web of molecules is its ability to hold a lot of water! Parts of a collagen molecule are responsible for its firm structure, while other parts bond with water molecules. In warm water, the water molecules can slide in between the collagen molecules and fold their inner structure together. This happens when the gelatin is dissolved. When cooled off, the collagen molecules connect themselves together again and as a result form a network that can make liquids firm.

← *A computer rendering of the long twisted chains of collagen molecules.*

CARRAGEENAN

Carrageenan is another ingredient that is commonly used to make gels. Carrageenan comes from certain types of plant-like organisms called red algae. Like gelatin, it contains long chains of polymers that can form big tangled webs that can hold a lot of water molecules in them. These molecules are called **polysaccharides.** These are different from the collagen molecules in gelatin, but they also produce gels.



Red algae seaweed

Red algae seaweed

AGAR-AGAR

Agar-agar is another gelling agent that comes from polysaccharides in red seaweed. In the seaweed plant cells, agar-agar forms part of the cell wall, or the outer protective layer of the cell. Agar-agar molecules form a spiral shape called a double helix.

← *Agar-agar powder*

↓ *A dessert made with agar-agar*

KITCHEN CHEMISTRY

3. Red cabbage indicator

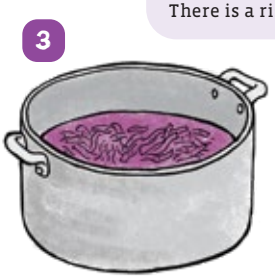
Safety Note: Caution! High temperatures. There is a risk of burns.

You will need:

Small red cabbage, knife, cooking pot, spoon, water, strainer, glass jar

Here's how:

1. Ask an adult to help you with this experiment.
2. Chop up the leaves of a small red cabbage.
3. Place the chopped cabbage in a cooking pot and add enough water to completely submerge the cabbage.
4. Place the pot on the stove. Set the stove burner to high and bring the contents of the pot to a boil. Let them boil for about 15 minutes. Then, remove it from the heat and let it cool.
5. After the pot has cooled, use the strainer to separate the cabbage from the liquid in the sink, keeping the liquid.
6. Store the liquid in a small, clean glass jar. Attach a label to the jar.



GEEK OUT!

WHAT'S HAPPENING?

In this experiment, you made a purple solution called an **indicator.** You will use this indicator in the next experiment. Red cabbage contains substances called **anthocyanins.** These substances are pigment molecules that change color depending on the acidity of a solution. By cutting up the cabbage and boiling it, you broke down the cabbage tissue that contained the anthocyanins. The anthocyanins were released into the solution, turning the water purple. In the solution, the anthocyanins can easily move around and react to chemicals added to the solution.

4. Sour and bitter

You will need:

Sour-sugar coating scraped off a sour gummy candy, water, red cabbage indicator, small bowl, baking powder

Here's how:

1. Take a pinch of the sour-sugar coating and mix it in 2 ml of water. Add the red cabbage indicator to the solution. What do you observe?

2. Pour half a cup of water into a bowl and mix in 1 tablespoon of baking soda. Add red cabbage indicator to the solution. What do you observe?

With adult supervision as always, test these other substances from your home with the red cabbage indicator. What do you observe?

GEEK OUT!

WHAT'S HAPPENING?

When red cabbage indicator is added to the sour-sugar coating and water solution, it changes to a red color. The reason the red cabbage solution turns red is because there is **acid** in the sour-sugar coating. This acid is called citric acid, which occurs naturally in citrus fruits like lemons and limes. That is why the sour-sugar coating tastes sour!

When the red cabbage indicator is added to the water and baking soda solution, it turns green. That is because baking soda is a **base.** Bases are slippery to the touch and have a bitter taste. Don't eat the baking soda and water solution — it will not taste good!

GEEK OUT!

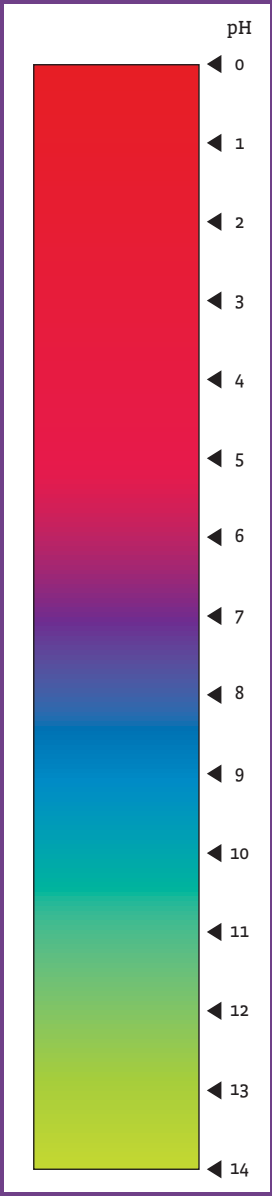
DETECTING ACIDS AND BASES

An **acid** is a substance that gives off hydrogen ions (H^+) when dissolved in water. **Bases** are substances that give off hydroxide ions (OH^-) when dissolved in water. You encounter many acids and bases every day. A few common examples of acids are vinegar, lemon juice, the hydrochloric acid your stomach uses to digest food, and the sulfuric acid used in car batteries. Baking soda, ammonia, and many household detergents are bases.

How do you know if a liquid is an acid or a base? Scientists use a substance called an **indicator** to determine if a liquid is acidic or alkaline (basic). An indicator will change color if it is placed in an acid or a base. Many plants, such as cherries, violets, blueberries, and black currants contain natural dyes that change color in acids and bases. These dyes are grouped under the name **anthocyanins.**

Chemists use the **pH** system to measure acidic and basic solutions. pH stands for "potential of hydrogen," and the p is lowercase while the H is capitalized. The pH scale goes from 0 to 14. Values below 7 are acidic and values above 7 are alkaline. Pure water has a pH of 7, which is considered **neutral** — neither acidic or alkaline.

As you already learned, red cabbage contains anthocyanins allowing it to be used as an indicator. The image to the right shows how chemicals with different pH levels make red cabbage juice turn different colors — acids make it turn reddish, and bases make it turn more bluish or greenish. It is purple when the pH is 7 and the solution is neutral. This means you can use red cabbage to tell the pH of a substance, which is exactly what you did in this experiment: You added different acids and bases to the cabbage juice, and the juice told you their pH levels by changing color.



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First aid information

Advice in case any accidents should happen during experimentation.

1. In case of burns: Wash affected area with plenty of water for at least 10 minutes.
2. In case of doubt or larger burns, seek medical advice without delay.
3. In case of injury (e.g. cuts) always seek medical advice.

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