EXPERIMENT MANUAL

Ages 6+

RaiNBoW GuMMY CANDY LAB

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, Canola Oil, Natural and Artificial Flavors, Cornstarch, Citric Acid, Malic Acid, Colors (Titanium Dioxide, Red 40, Yellow 5, Blue 1).

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 him or her 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 him or her 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.*

KIT CONTENTS

1	Sour mixture (Net Wt. 30 g/1.05 oz)
2	Cherry (red) gummy candy mix (Net Wt. 50 g/1.76 oz)
3	Raspberry (blue) gummy candy mix (Net Wt. 50 g/1.76 oz)
4	Banana (yellow) gummy candy mix (Net Wt. 50 g/1.76 oz)
5	Vanilla (white) gummy candy mix (Net Wt. 50 g/1.76 oz)
6	Plastic gummy candy mold
7	Plastic storage bags (4)
8	Sticker sheet for labeling bags

For the ingredient lists, see the inside front cover.

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, food coloring, tablespoon and teaspoon, microwave-safe plates, microwave*

Hey Gummy Scientists!

Want to make yummy gummy candy treats in all the colors of the rainbow — *and* learn some physical science while you're at it? Then let's get started! After you've made your gummy shapes, you can wrap them in a plastic bag and label it with the included labels. 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:

Vanilla White Clouds
Page 4

One- or Two-Color Unicorn
Page 6

Three-Color Rainbows
Page 7

Six-Color Rainbows
Page 8

Notes:

- You can simply follow the general instructions below to make gummies in the colors and flavors of your choice. However, to make the gummies above, follow the step-by-step instructions starting on the next page.
- These gummies will not turn out exactly the same as commercial store-bought gummies. See pages 12–13 to learn about different gels.
- One 50-gram packet fills the plastic gummy molding tray about 75–100% full, depending on how full you make each mold.

- **Read all of the instructions carefully before starting.**
- **Follow the instructions precisely.**
- **Prepare to work quickly, as the gummy mixture solidifies quickly.**

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** 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, 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.

Continued on next page →

1. Vanilla White Clouds

You will need:

- **1 Tablespoon vanilla gummy candy mix**
- **Plastic gummy molding tray**
- **1 Teaspoon sour mixture**
- **Plastic storage bag**
- **Stickers**
- *Scissors*
- *Tablespoon*
- *Teaspoon*
- *Water*
- *Small bowl*
- *Spoon*
- *Toothpick or fork*
- *Plate*

Here's how:

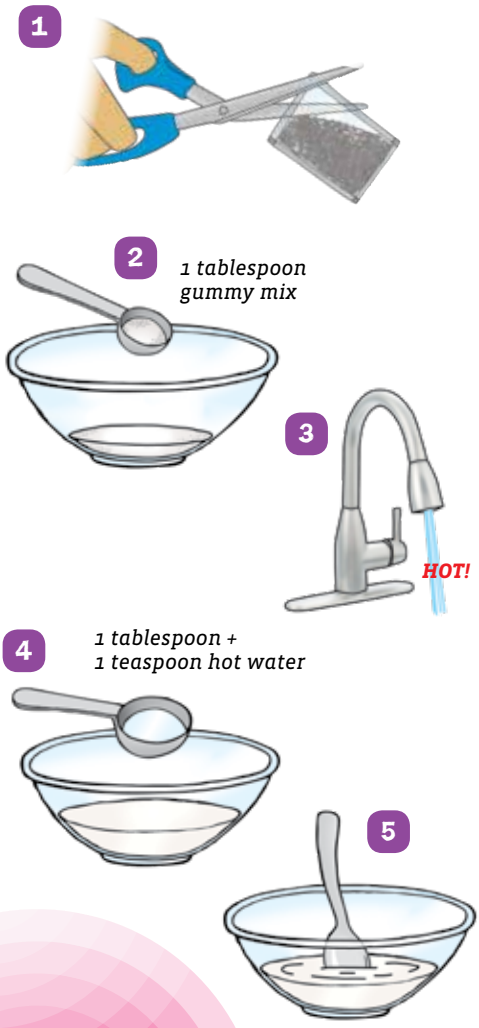
1. Cut open the vanilla (white) gummy mix packet with scissors.

2. Measure **1 level tablespoon of white gummy mix** and put it into a small bowl.

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

4. Measure **1 tablespoon plus 1 teaspoon (= 4 teaspoons) of hot water** and pour it into the bowl.

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



Here's how it continues:

6 Spoon the mixture into the cloud-shaped molds in the tray.

7 Put the tray into the refrigerator and let the gummies solidify for five to ten minutes.

8 After the gummies have solidified, remove them from the molds using a toothpick or fork. Do not bend the plastic tray excessively to remove the gummies.

9 Optional: If you want to make sour gummies, cut open the sour mixture packet and place the gummies and one teaspoon of the sour mixture together into a plastic bag. Shake the bag to coat the gummies with the sour mixture.

10 Place the gummies in a plastic bag. Close the bags using a sticker from the sticker sheet. Store the gummies in the plastic bags in the refrigerator. Consume the gummies within one week.

There is enough white gummy mix to repeat this four times. Save 1 tablespoon of white gummy powder for the six-color rainbows experiment on page 8.

Done!

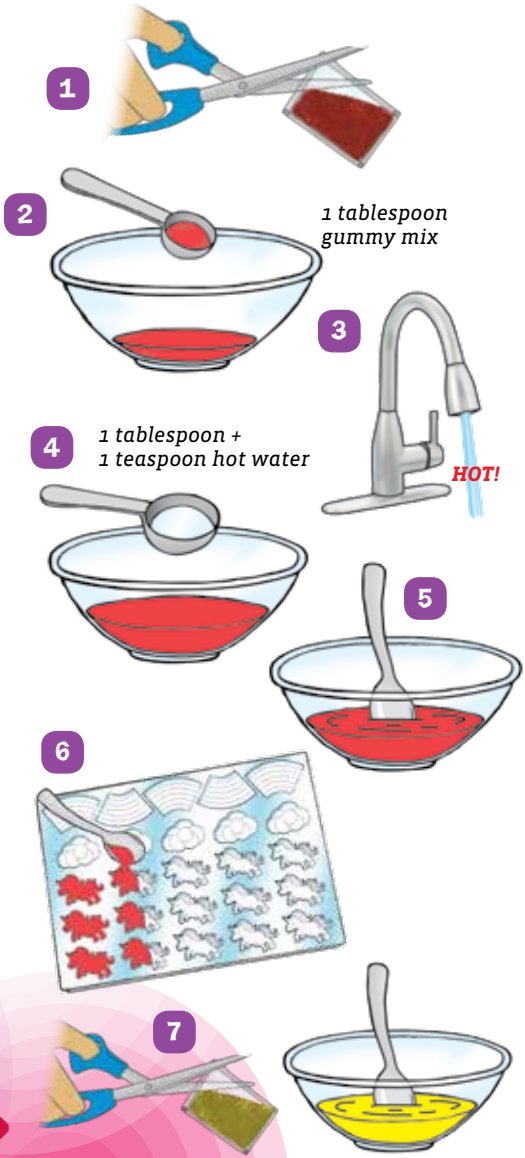
2. One- and Two-Color Unicorns

You will need:

- **1 Tablespoon cherry gummy candy mix**
- **1 Tablespoon banana gummy candy mix**
- **1 Tablespoon raspberry gummy candy mix**
- **Plastic gummy molding tray**
- **1 Teaspoon sour mixture**
- **Plastic bag**
- **Stickers**
- *Scissors*
- *Tablespoon*
- *Teaspoon*
- *Water*
- *Small bowl*
- *Spoon*
- *Toothpick or fork*
- *Plate*

Here's how:

1. Cut open the cherry (red) gummy mix packet with scissors.
2. Measure **1 level tablespoon of cherry gummy mix** and put it into a bowl.
3. Turn on the hot water faucet and let the water run until it is as hot as it gets.
4. Measure **1 tablespoon plus 1 teaspoon of hot water** and pour it into the bowl.
5. Stir the mixture with a spoon until the gummy mix is completely dissolved and the mixture appears smooth.
6. Working from left to right on the molding tray, spoon the mixture into the first column of unicorn molds. Continue with the next column of unicorn molds, partially filling each mold until they are about two-thirds full.
7. Repeat steps 1 through 5, but with the banana (yellow) gummy mix.



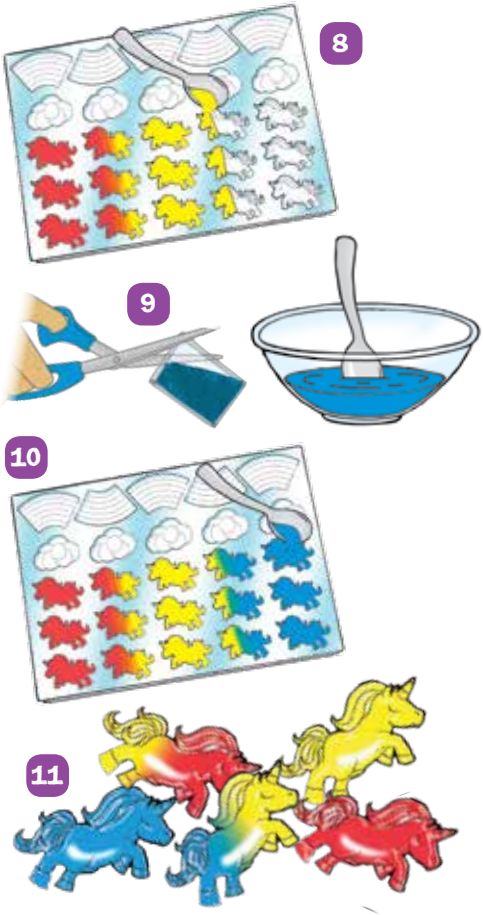
Here's how it continues:

8. Spoon the yellow mixture to fill the remaining thirds of the unicorn molds that are partially filled with red mixture. Fill the third column of molds completely with yellow mixture. Fill a third of the next column with the rest of the yellow mixture.

9. Now repeat steps 1 through 5, but with the raspberry (blue) mix.

10. Spoon the blue mixture to fill the remaining two-thirds of the unicorn molds that are partially filled with yellow mixture. Finally, fill the last three unicorn molds with blue mixture.

11. Follow steps 7 through 10 of Experiment 1 (White Vanilla Clouds) to harden the gummies and remove them from the molds, coat them in the optional sour mix, and package them.



3. Three-Color Rainbows

You can follow the same general procedure in Experiment 2 to make multicolored rainbows.

Here's how:

1. Mix 1 tablespoon of red gummy mix with 1 tablespoon plus 1 teaspoon of hot water.
2. Fill one third of each of the rainbow molds with the red mixture.
3. Repeat with the yellow and blue mixtures, filling the rainbow molds.
4. You will probably have a little mixture left over each time; spoon it into the free unicorn or cloud molds.
5. Follow the previous instructions for finishing your gummies.

4. Six-Color Rainbows

Scan this QR code to go to an instructional video for this experiment.

Here's how:

Warning! This is the most challenging experiment, because you must carefully fill each arc of the rainbow.

1. We suggest using a small measuring cup with a pour spout, or a paper cup that is folded to have a make-shift spout, to pour the gummy mixtures precisely.

2. Mix **¾ teaspoon of yellow gummy mixture** and **¾ teaspoon of blue gummy mixture** with **2 teaspoons of water**, to form a green mixture.

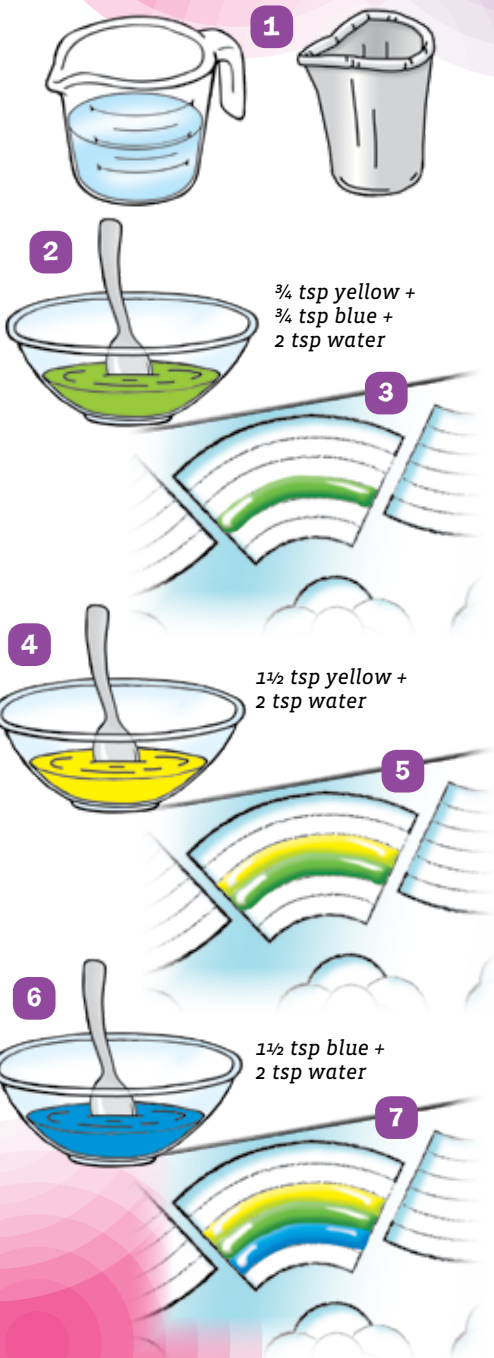
3. Carefully pour the green mixture into the fourth arc of the rainbow, in all five rainbow molds. If you want more clearly defined arcs of color, wait a few minutes after pouring one color before pouring the next color. (If you ever have extra mixture, pour it into the unicorn molds.)

4. Mix **1½ teaspoons of yellow gummy mix** with **2 teaspoons of water.**

5. Fill the third arc of the rainbows with the yellow mixture. When filling the arcs, make sure there is a lot of contact between the two colors.

6. Mix **1½ teaspoons of blue gummy mix** with **2 teaspoons of water.**

7. Fill the fifth arc of the rainbows with the blue mixture.



Here's how it continues:

8 Mix **¾ teaspoon of red gummy mixture** and **¾ teaspoon of yellow gummy mixture** with **2 teaspoons of water,** to form an orange mixture.

9 Fill the second arc of the rainbows with the orange mixture.

10 Mix **¾ teaspoon of red gummy mixture** and **¾ teaspoon of blue gummy mixture** with **2 teaspoons of water,** to form a purple mixture.

11 Fill the sixth arc of the rainbows with the purple mixture.

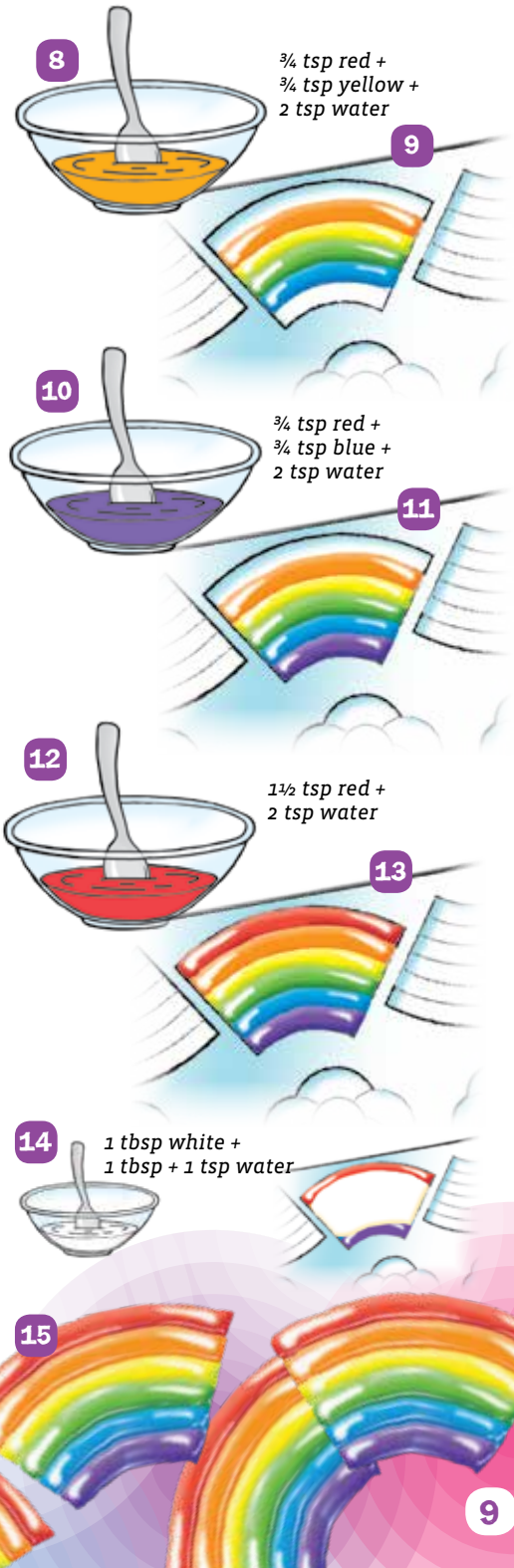
12 Finally, mix **1½ teaspoons of red gummy mix** with **2 teaspoons of water.**

13 Fill the first arc of the rainbows with the red mixture.

14 Optional: Mix **1 tablespoon of white gummy mix** with **1 tablespoon plus 1 teaspoon of water.** Use this mixture to fill in the rest of the molds, which will become the backs of the rainbow gummies when finished.

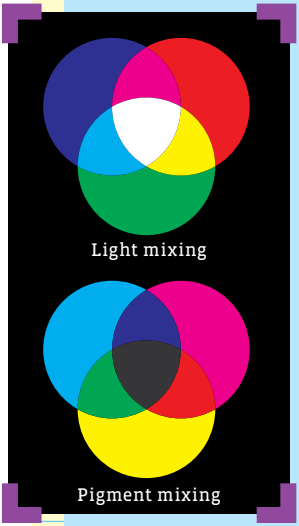
15 Follow the previous instructions for finishing your gummies.

There is enough red, yellow, and blue gummy mix to do Experiment 2, 3, or 4 a second and third time. Each of these experiments requires 3 tablespoons of gummy mix (1 tablespoon of each color, not including white), so you can do any two of them twice.



GEEK OUT!

THE SCIENCE OF COLOR



Light mixing

Pigment mixing

COLOR MIXING

What happened when you mixed the red and yellow gummy mix together? How about when you mixed red and blue? Why does mixing two colors of gummy mix together create a new color?

Light moves in waves. Our eyes see light waves of different wavelengths as different colors. We see light consisting of all wavelengths as white light. When you mix red, green, and blue light, you see white light.

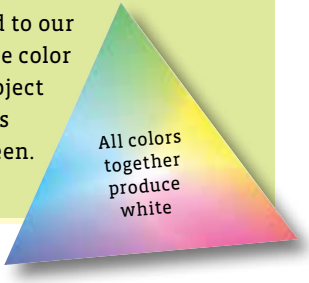
The gummy mixes are colored with dyes. Dye and pigments mix differently than light. Each color of dye absorbs some wavelengths of white light, subtracting those out of the color that reflects into your eye. The final color you see is made of whichever wavelengths are not absorbed by the dye particles.

THE COLOR DETECTORS IN YOUR EYE

We have three different detectors for color in our eyes. One type is best at recognizing red, another type recognizes green, and another type is best at recognizing blue. How is it, then, that we can see so many different colors and color gradations? Our brain creates the colors we see by calculating how strongly the three different types of detector are stimulated. Since these detectors require a certain amount of light in order to become activated, though, we cannot perceive any colors at night.

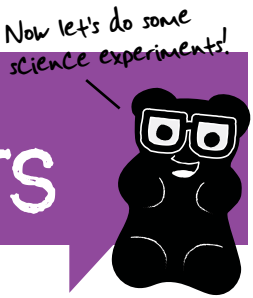
GRASS IS GREENER

Why do we perceive the grass as green, the sky as blue, and a rose as red? White light is composed of many colors. When this light arrives, for example, at a green tree, most of the light colors are "swallowed up" by the leaves, and only the green rays are reflected back. The color of the rays that are reflected to our eye is the color of the object — in this case, green.



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 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. 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.**

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

Red algae seaweed

Carrageenan is another ingredient that is commonly used to make gels. Carrageenan comes from certain types of plants 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

AGAR-AGAR

← *Agar-agar powder*

↓ *A dessert made with 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.

2. Measuring volume

You will need:

Gummy mold tray, *measuring cup, food coloring, spoon, tablespoon, teaspoon*

Here's how:

1. Fill the measuring cup with exactly one cup of water.

2. Add two drops of food coloring. The purpose of the food coloring is only to make the water easier to see.

3. Using the spoon, carefully fill each mold in the tray with colored water. Try not to let any water drip outside of the molds.

4. When the tray is full, look at how much water is remaining in the measuring cup. Subtract this number from one cup to determine how much liquid the gummy mold tray holds.

   How much water does it hold?

   How might you calculate how much water each cavity holds?

GEEK OUT!

WHAT'S HAPPENING?

The gummy mold tray holds about two-thirds of a cup of liquid. To calculate the volume of each cavity, you could use a small measuring spoon to measure each cavity separately, or you could assume each cavity is approximately the same size and divide the total volume by the number of cavities. This type of assumption is common in science, but when sharing your calculated volume, be sure to include that it was based on assumed knowledge and was not measured exactly. This is the level of detail scientists use when reporting their results!

3. Melting and freezing

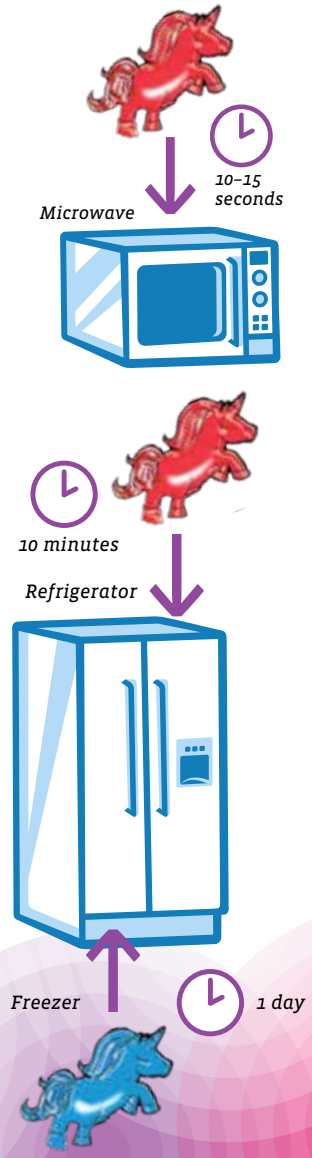
You will need:

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.

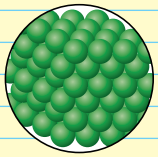


GEEK OUT!

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.

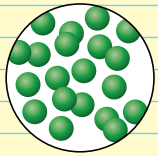
The atoms of **solids** are packed together densely and have fixed positions in space relative to each other (like bricks in a wall), which makes solids rigid.



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

Kosmos Quality and Safety

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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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