SCIENCE AT HOME

COOKIE CHEMISTRY

GRADE: **9**

SNC1D, SNC1P
SUBJECT: CHEMISTRY
STRAND: ATOMS, ELEMENTS AND COMPOUNDS
TOPIC: CHEMICAL AND PHYSICAL PROPERTIES
EXPECTATIONS: SNC1D: A1.4, A1.10, C2.2, C2.3, C2.4
SNC1P: A1.4, A1.10, C2.2, C2.3, C2.4
VIDEO: youtu.be/8hFcAtdn9OY

INTRODUCTION:

What goes into making a great chocolate chip cookie? Think about crispness, softness, chewiness and how much it spreads out as it bakes. Preparing the ingredients and baking the dough create chemical and physical changes. Think about how the chemical and physical properties of your ingredients will affect how the cookie comes together.

Fats, such as butter, change the melting point of the dough, which changes the spread and size of the cookie and how the cookie sets.

Leavening agents, such as baking soda and baking powder, interact with the other ingredients to create gases, which make the cookie expand.

Gluten, a protein in flour, reacts with water to form long strands in the dough, making it elastic and stretchy. Gluten helps the dough hold on to water and maintains the cookie's structure as it bakes.

In addition to sweetening the cookie, sugar undergoes both physical and chemical changes during baking. It melts into a liquid and molecularly breaks apart through a process called "caramelization."

You can use cookies to explore some of this chemistry. Change the way a cookie spreads, for instance, by changing the kind or amount of fat you use. Change how much a cookie rises, by swapping out one leavening agent for another. Then, decide what's most important to you and develop your own custom recipe.

ACTIVITY: Make CO_2 rise

Start by creating three chemical reactions that release carbon dioxide (CO_2) gas.

TIME: 15 minutes

WHAT YOU NEED:

- 3 identical balloons
- 3 plastic bottles
- Measuring spoons
- Measuring cup
- Timer
- Measuring tape, ruler or string
- Funnel
- Someone to help

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WHAT YOU NEED (continued):

- Water at room temperature (60 mL)
- Water warmer than room temperature, at least 40°C (60 mL)
- Yeast (15 mL)
- Sugar (15 mL)
- Baking soda (15 mL)
- Baking powder (15 mL)
- Vinegar (60 mL)

Note: 15 mL is approximately 1 tbsp

WHAT YOU DO:

- Label the bottles "yeast," "baking soda" and "baking powder."
- Measure the initial diameter of the balloons.
- Using a funnel, fill the first balloon with 15 mL of yeast, the second balloon with 15 mL of baking soda and the third balloon with 15 mL of baking powder.
- Into the bottle labelled “yeast,” pour 60 mL of warm water and add 15 mL of sugar. Shake to dissolve the sugar, then seal the yeast-filled balloon to the rim or “lip” of the bottle. (Don’t tip the yeast into the water yet!)
- Into the bottle labelled “baking soda,” pour 60 mL of vinegar. Seal the baking-soda-filled balloon to the lip of the bottle. (Don’t tip the baking soda into the vinegar yet!)
- Into the bottle labelled “baking powder,” pour 60 mL of room-temperature water, then seal the baking-powder-filled balloon to the lip of the bottle. (Don’t tip the baking powder into the water yet!)
- With someone else's help, gently tip the contents of the balloons into the bottles and start the timer.
- Measure and record how much the balloons inflate after 30 seconds, one minute, three minutes, five minutes and 10 minutes.
- The gas that inflates the balloons is CO_2, the same gas that helps baked goods like cookies and bread “rise” and develop a crumbly texture once baked. When you're baking your own cookies, think about how each leavening agent expanded the balloons differently.

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ACTIVITY: Baking cookies for science

This recipe makes 18 cookies.

TIME: 30 minutes

SAFETY:

Don't leave the oven unattended when baking.

Use oven mitts when taking things out of the oven.

Let the cookies cool for a few minutes before you eat them.

WHAT YOU NEED:

Ingredients:

- 1 1/2 cups (200g) all purpose flour
- 1/2 cup (80g) white sugar
- 1/2 cup (80g) brown sugar
- 2/3 cup (160g) butter at room temperature
- 1½ tsp (6g) salt
- 1/2 tsp (3g) baking soda
- 2 tsp (10g) vanilla
- 1 large egg
- 1 cup (150g) chocolate chips

Tools:

- Oven
- Oven mitts
- 2 large mixing bowls
- Measuring cups
- Measuring spoons
- Food scale (optional)
- Baking sheet
- Mixer or a fork
- Wooden spoon (or a strong mixing spoon)
- Spoon or ice cream scoop (for scooping dough out onto tray)
- Parchment paper or silicone mat (optional)

WHAT YOU DO:

- Preheat the oven to 350°F (180°C).
- Measure the butter and beat it with the mixer (or a fork) until it's creamy.
- Add both brown and white sugars, and beat the mixture until it's light and fluffy.
- Mix in the vanilla and the egg, then turn the mixer to high or get your fork ready. Beat the dough vigorously.
- In a separate bowl, mix together the dry ingredients.
- Slowly add the dry ingredients to the wet. Use the wooden spoon to mix, but be careful not to over-mix. Stop when you can no longer see the flour.

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WHAT YOU DO (continued):

- Stir in the chocolate chips.
- Line the baking sheet with parchment paper or a silicone mat. Drop tablespoon-sized balls of cookie dough onto it. Bake for 12 to 15 minutes — or until the cookies start to get brown around the edges.

WHY THIS MATTERS:

The physical and chemical properties of a compound determine its function in our daily lives. Consider the baking sheets that you baked your cookies on: are they made from aluminum, steel or silicone? How do the properties of those materials compare, and why would they then be good (or not) for baking on? A silicone rubber baking sheet, for instance, is a synthetic polymer made from silicon and oxygen. Silicone has low thermal conductivity, which means it transfers heat at a lower rate than some other materials — great if you want your cookies to bake evenly and without scorched bottoms.

But understanding a material's properties is important for more than baking. It is central to the field of materials science, which involves creating new materials and applying already-discovered substances in novel ways. Let's think about another everyday use of silicon and oxygen compounds: the insides of the computer or phone you are using. Electronic devices contain many integrated circuits, also made from silicon. Understanding chemical reactivity and physical properties like melting point are key to turning silicon dioxide — sand — into silicon wafers, computer chips and these circuits.

TAKING IT FURTHER: Ask, taste, repeat

Now try to come up with a recipe that is even better. Use the above cookie recipe, and the cookies it produced, as a control. Before you experiment, here are some things to consider:

- What kind of texture do you want?
- What ingredients would you like to substitute?
- How do you change the recipe to make a smaller yield?
- Can you make a recipe with only ingredients you already have at home?
- What would happen if you changed the temperature of the oven or of the dough before baking?
- Create a chart like the one below to keep track of your modifications.

Change	Cookie diameter (cm)	Taste (Better / Worse / Different but equal)	Chewiness (More / Less / Different but equal)	Softness (More / Less / Different but equal)	Colour (Darker / Lighter / Different but equal)
Control (original recipe)					
Baked at 400°F (205°C)					

When you have devised your ideal cookie recipe, please share it with us through social media! Tell us what you did, why you did it and how it turned out. Happy cookie experimenting!

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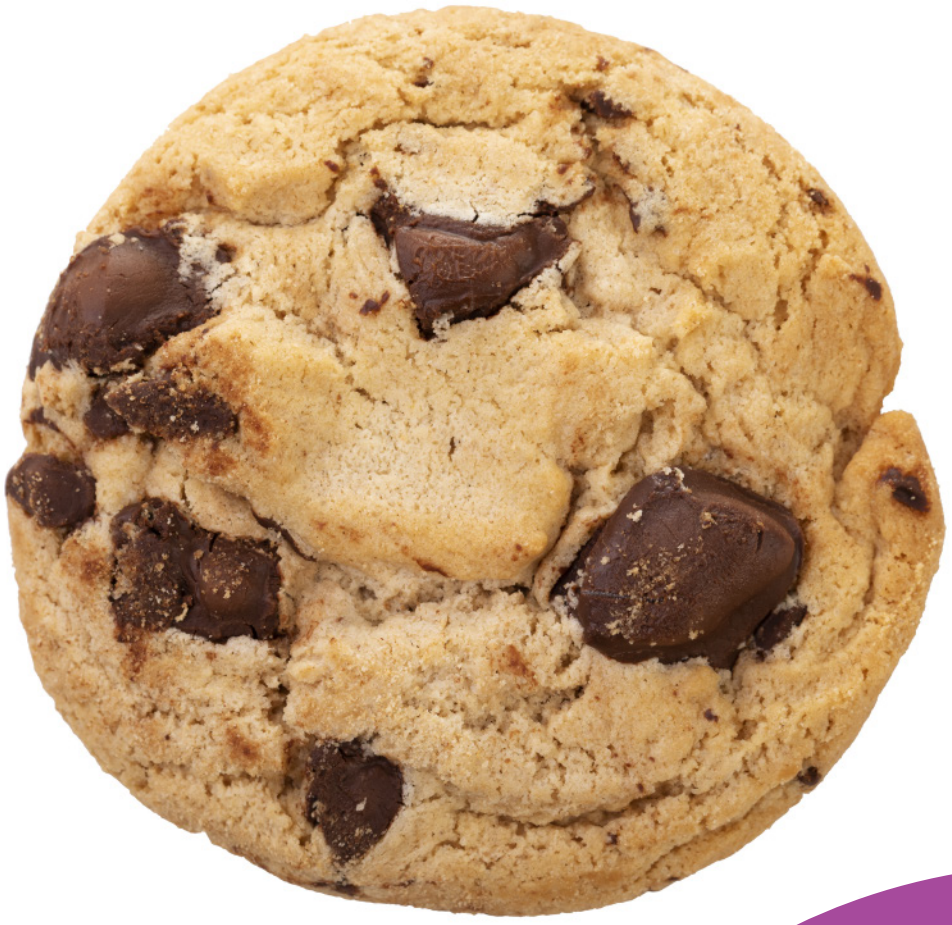
MORE ONLINE:

The chemistry of cookies
https://www.youtube.com/watch?v=n6wpNhyreDE

Ingredient substitutions
https://extension.colostate.edu/topic-areas/nutrition-food-safety-health/ingredient-substitutions-9-329/



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