



Be a Scientist!

As described in the book, two different proteins in flour bind together to form gluten in dough.

Ask an adult to gather two or three types of flour with different levels of protein. (Don't peek at the protein content!) Measure an equal amount of each type of flour into separate bowls and add the same amount of water to each. Knead each mixture for ten minutes. Rinse each mixture under a faucet until the water runs clear. Most of the starch and other substances will wash out of the mixture until only the gluten remains.

Compare the balls of gluten. What is the texture like? Are they all the same size? Use a scale to weigh each gluten ball. Which ball has the most gluten? Try to determine which ball of gluten came from each type of flour.



Beyond the Book

Pick one world culture and investigate how the people use bread. Do they use leavening agents? Is bread used for special ceremonies?

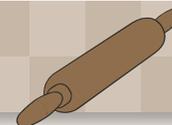
FOCUS Book

THE SCIENCE OF BAKING



: Science A-Z 

Notes



THE SCIENCE OF BAKING



FOCUS Question

What are the physical and chemical changes that take place during baking?

Energy and Matter

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Oven Chemistry

Mmmmmm! Don't you love the smell of something delicious baking in the oven? Believe it or not, gooey cookies, fluffy cake, and warm bread are all made using chemistry. When a baker mixes together the right ingredients in the right order, the atoms inside start to interact.

Each ingredient has a task, and once heat is added, a blob of batter transforms into a tasty baked treat. Let's find out why these kitchen chemical reactions taste so good!



Ingredients and heat react to create tasty treats!

Notes



Read-Think-Write

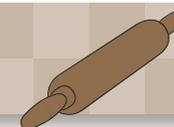
Write your answers on separate paper. Use details from the text as evidence.

- 1 What does the word *solution* on page 3 mean, and why is cake batter an example of a solution?
- 2 Too much gluten can make a cake dense and chewy. Which method of preventing this problem seems easier, and why?
- 3 Compare the two types of leavening agents on page 6 and describe how they each work.
- 4 According to the text, how is yeast similar to baking soda, and how is it different? Consider what each one is made of and how each one behaves.
- 5 Using the chart on page 9, what would be the properties of cake batter that has reached 125°C?



FOCUS Question

What are the physical and chemical changes that take place during baking? Name two physical changes and two chemical changes from the text, and discuss how they work together to make a delicious cake.



Mixing It Up

Let's bake a cake! Combine the dry ingredients, or *reagents*—flour, baking powder, and salt—into a *mixture*. Separately, mix the butter and sugar. The sugar doesn't dissolve, but it spreads evenly throughout the butter. You have created a *colloid*. Add the dry mixture to the colloid and then blend in the eggs, milk, and vanilla. Now you have a thick *solution*.

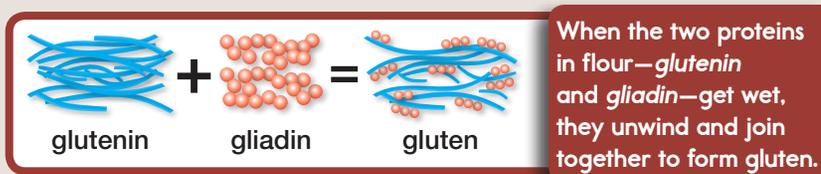
Mixtures, colloids, and solutions are all the result of physical changes. Some physical changes are easy to undo, like picking raisins out of trail mix. But with cake batter, you can't easily separate the ingredients once they are combined. This kind of physical change is what allows bakers to create something new, like a cake!





A Sticky Framework

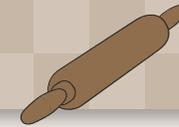
Like the frame of a building, a cake needs a structure, or framework. Without it, the cake will collapse into a pile of crumbs. *Gluten*, a protein substance found in wheat flour, provides that structure. When the flour gets wet from the milk and eggs, two proteins join to form long strands of gluten. Mixing the batter creates even more gluten, which holds everything together.



Gluten molecules have links between them that hold them together and make them *elastic*, or able to bounce back. This property allows cake and bread to rise, but too much gluten can result in chewy bread or dense cake. Not so yummy! To prevent this problem, bakers use flour with the right amount of protein for their bread or cake recipe, and they don't overstir the batter.

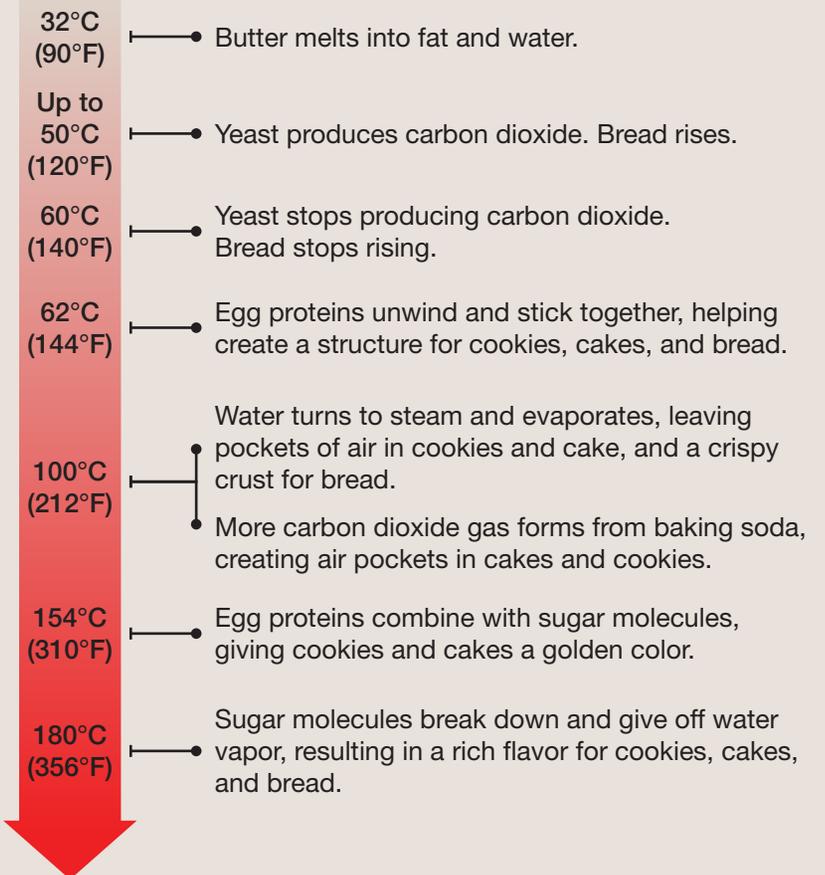
Think About It

If you have ever tried to stretch out pizza dough, you know that it springs back when you let go. Why do you think it does that?



At even higher temperatures, egg proteins and sugar molecules combine to produce rich flavors and a deep golden color. You can smell the delicious scent of your cake, cookies, or bread, and it's hard to wait for the . . . *ding!* Better take your treat out of the oven before it burns. Physical changes and chemical reactions created a wonderful treat. Thanks, chemistry!

PROPERTIES OF BATTER AS ITS TEMPERATURE INCREASES





In the Oven

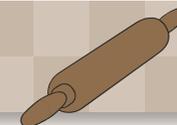
Whether you are making bread, cookies, or cake, you need a hot oven to ignite the chemical reactions that create the final product. Different reactions happen as the dough or batter heats up. Below 50 degrees Celsius (120°F), the yeast releases carbon dioxide, and the bread expands. Once the dough hits 60°C (140°F), the yeast stops working and the bread stops rising.

At 62°C (144°F), the strands of proteins from the eggs unwind and stick to each other in long, tangled strands. Along with the gluten, they help form the structure for the air pockets in the baked good.

At 100°C (212°F), baking soda produces even more carbon dioxide gas bubbles. As this gas seeps out, it leaves pockets of air in the batter. Water molecules near the surface of the bread or cake turn to steam and evaporate, leaving a crispy crust.



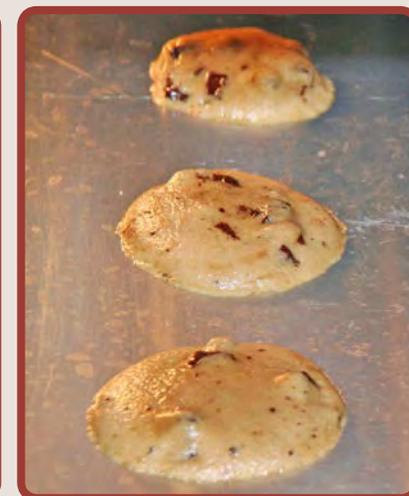
It's important to use the right temperature when baking because different chemical reactions occur at different temperatures.



Rising Up

Now you have a solution of batter with gluten ready to provide a framework. But your batter is still a bowl of goo. To get an airy cake or other baked goods, you need bubbles in the batter in order to expand the elastic gluten framework.

Cookie dough uses the properties of butter to create some of the bubbles. Butter is an *emulsion*—a glob of water, fat, and solid dairy products all stuck together. Inside the hot oven, the butter in your cookie dough melts. The dough flattens out, and the water in the butter separates from the fat and dairy. The water molecules turn to steam, forming bubbles that make the cookie dough rise slightly.



Thick cookie dough flattens out in the oven. After more baking, the bubbles from the steam push against the gluten framework, causing it to rise.



Heavy Lifting

The real heavy lifter in baked goods is called a *leavening* (LEH-vuh-ning) agent. One of the chief leavening agents is baking soda, or *sodium bicarbonate*. Even before you place the cookie dough into the oven, the sodium bicarbonate begins to react with acids in the dough and creates carbon dioxide gas. In the oven, this reaction speeds up. The gas expands, opening air pockets in the gluten structure. This chemical change causes the dough to rise. It is impossible to reverse this step.

Baking powder—baking soda mixed with an acid—is often used for cake batters that don't already have acid in them. It makes carbon dioxide gas as soon as it contacts the other ingredients, and it reacts further when heated in the oven. Lots of carbon dioxide gas bubbles create a fluffier cake!

REACTION OF BAKING SODA AND VINEGAR



baking soda

+



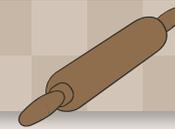
acid

=



water and carbon dioxide

The reaction of baking soda with an acid, such as vinegar, creates water and carbon dioxide gas.



Adding Life to Your Cake

Not all baked goods use baking soda or baking powder. Most breads use a different kind of leavening agent—a living one! *Yeast* is a living organism that feeds on the starch or sugar in the warm, moist bread dough. It gives off carbon dioxide gas as it digests the sugar. This process is called *fermentation*. The bubbles of carbon dioxide create pockets in the bread dough and cause it to rise when baked.

Because yeast is a living organism, it needs time to digest the sugar and create carbon dioxide gas. Bakers leave bread dough in a warm place to let the yeast work for one to two hours so the dough will rise. As the dough bakes in an oven, the gas expands and causes the bread to rise even more.

Do You Know?

Tasty bread doesn't always need to rise! People around the world eat various forms of *unleavened bread*, or bread without a leavening agent.

matzo



roti



tortillas



pita

