Science V9/S3: Role of Heat in Baking

Baking and cooking are processes we take for granted. Place something raw on the grill and very soon you have an edible meal. Baking is thought to have started 10,000-14,000 years ago. Though **baking** seems simple, it is a complex scientific process involving heat and molecules. Baking is a scientific experiment you can actually eat.

Heat is the total amount of energy used in the temperature of a process. **Temperature** measures the motion of **molecules** in an object. To cook is to use heat to create a chemical reaction in food, and temperature is how much heat it takes for that reaction to occur. These chemical reactions are irreversible. Once you cook a steak you cannot make it raw again. In the same way, heat causes chemical changes in the ingredients of a baked good that cause it to change forms. This change can be seen through the process of baking cookies. The cookie dough melts, hardens, and then expands within a short period of time.

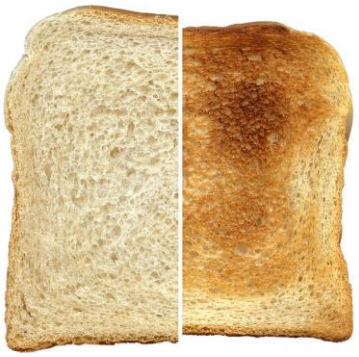
Chemical Reaction in Cookies		
Room Temperature Cookie dough does not change.	**92°F/33°C** The butter melts and spreads.	**144°F/62°C** Heated proteins turn eggs solid.
		

Using heat in food preparation allowed humans to unlock helpful nutrients and kill harmful bacteria. Cooking made more foods available to humans in a way it hadn't been before. For example, eggs (used frequently in baking) can contain the harmful **Salmonella** bacteria. In fact, every year an estimated 142,000 people are infected with Salmonella from undercooked eggs. Even though Salmonella bacteria can withstand the freezing cold, it dies at a temperature of 136°F/57°C. Therefore, baking turns cookies from possible illness inducing discs to delicious treats.

212°F/100°C Cookies expand.	**356°F/180°C** Sugar caramelizes.
	

Temperature is important in baking because it controls flavor, color, and moisture. Temperature causes a process to occur called the **Maillard Reaction**. The Maillard Reaction happens when proteins and sugars are changed by heat and moisture. Heat causes the sugar molecules to break down and interact with the protein molecules.

This process causes baked goods to look, smell, and taste different. For example, a piece of toast looks browner and smells more aromatic than an untoasted piece of bread. The heat breaks down the sugars in the bread, caramelizing it and creating a tastier snack. **Caramelization** happens at about 356°F/180°C and lasts until 390°F/199°C. It is the last reaction to occur when baking.



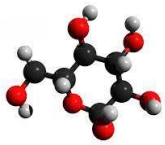
If you bake a lot at home, you might have noticed that most recipes call for a temperature of 350°F/176°C. If an item is baked at too low of a temperature, the water will **evaporate**, resulting in a drier baked item. If the item is baked at too high of a temperature, the outside of the item will reach the Maillard Reaction process before the inside, resulting in a burnt outside and undercooked inside. Even though 350°F/176°C is the guideline for baked goods, many bakers purposefully alter these temperatures to create their desired results.

Baking

Heat

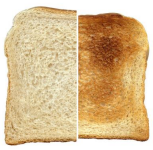
Temperature

Molecules



Salmonella

Maillard Reaction



Caramelization

Evaporate