

The Chemistry of Cooking

What we know as cooking is a variety of chemical reactions that change the structure of the food or form new structures as ingredients combine. These changes happen when chemical bonds are broken and new ones form. A chemical bond holds atoms together to form molecules. This bond is usually the result of atoms sharing or transferring electrons. For example, a water molecule is made up of two hydrogen atoms and one oxygen atom. The oxygen shares one electron with each hydrogen, forming a single bond with each of them.



Meat browns due to the Maillard Reaction.

Maillard Reaction

The Maillard Reaction is responsible for many of the changes we see and smell when we cook food. It's why meat and bread is brown. Maillard is an oxidation-reduction or redox reaction that occurs between amino acids and sugars. Redox reactions involve the transfer of electrons from one atom to another. The atom which gains one or more electrons has been reduced; the

atom which loses one or more electrons has been oxidized.

Amino acids are organic (carbon-based) molecules that are used to make proteins. The amino acids are linked together in strands and sheets which are then folded into shapes that allow them to perform their specific function. In cooking, the protein bonds are broken.

Raw meat contains both protein and sugar in the form of ribose, a simple sugar that is particularly reactive with amino acids. The amino acids in the protein are bound together by bonded coils which uncoil and break when heated. The heat also stimulates the redox reaction in which the protein myoglobin undergoes iron oxidation – the iron molecules lose an electron. During the reaction, red meats turn from red to brown. White meats, such as poultry, turn from pink to white because they have significantly less myoglobin and therefore undergo a lesser reaction. The reaction also produces water, which evaporates in the heat. This is why overcooked meat is dry.

Marinades

Reading Sample



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Foams

The creation of foams, such as meringue and whipped cream, involves another reaction in which protein bonds are denatured and new bonds are formed to develop a new structure. Proteins naturally have hydrophilic - or water loving - and hydrophobic - or water avoiding - parts. In its natural state, the hydrophilic portions of the protein are on the outside, while the hydrophobic portions are on the inside.



Whipping eggs or cream to create a foam involves denaturing proteins and forming

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Cakes and quick breads that don't use yeast are also a type of foam. They use baking soda or sodium bicarbonate to create the carbon dioxide bubbles. When mixed with water and an acid like buttermilk, vinegar, or lemon juice, carbonic acid is produced – carbon dioxide in water.



Popcorn pops because of steam buildup within the hull.

Popcorn

Popcorn pops not because of carbon dioxide bubbles, but water vapor. About 13.5% of a popcorn kernel is water and its hull is sealed around the corn within. When popcorn is heated, the water inside boils and is converted into steam. The steam expands, creating heightened pressure within the sealed hull. At

180°C, the pressure has risen to almost 1000 kilopascals (kPa), the hull can't withstand the pressure and the kernel explodes. For reference, standard atmospheric pressure is around 100 kPa.

Reading Comprehension Questions

1. What is a chemical bond?
2. Name two common cooking products that are due to the Maillard Reaction.
3. Why
4. What does marinating do to meat?
5. What
6. What are
7. What does the yeast consume and what does it produce?
8. How
9. Why does popcorn pop?

Extension Questions

10. The Maillard
11. The

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