Lesson Title	Chemistry Sandwiches
Length of Lesson	90 mins.
Created By	Cheryl McLaurin
Subject	Chemistry
Grade Level	11-12
State Standards	3.c., 4.e.
DOK Level	2, 3, 4
DOK Application	Analyze, Observe, Explain Phenomena in Terms of Concepts
National Standards	9-12: B: Physical Science, C: Life Science
Graduate Research Element	Fungi are a major component of soil micro-fauna in the forms of mycorrhiza and yeast.

Student Learning Goal:
In this lesson, a loaf of bread will be made and baked, meat will be browned via the Maillard reaction, and bell peppers and onions will be caramelized, creating the makings for a sandwich. Students will learn about essential reactions that happen when cooking and where these reactions occur outside the kitchen. They will identify products, reactants, reaction type, and the effects of heat on reaction product and speed.

State Standards for 9^{th}-12^{th} Chemistry

3.c) Classify chemical reactions by type.

• Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation.
Students will evaluate caramelization, the Maillard reaction, and fermentation and determine that caramelization is decomposition, Maillard is synthesis, and fermentation is decomposition.

4.e) Describe and identify factors affecting the solution process, rates of reaction, and equilibrium. (DOK 2)

• Chemical reaction rates affected by temperature, concentration, surface area, pressure, mixing, and the presence of a catalyst
Students will discover that yeasts ferment sugars into carbon dioxide faster at higher temperatures, and that caramelization and the Maillard reaction don't occur without activation energy.

National Content Standards for 9-12

B: Physical Science: Chemical Reactions:

- Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.

C: Life Science: The Cell:

- Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by a large set of protein catalysts, called enzymes. The breakdown of some of the food molecules enables the cell to store energy in specific chemicals that are used to carry out the many functions of the cell.

Materials Needed (supplies, hand-outs, resources):

AP flour, active dry yeast, salt, oil, stand mixer, parchment paper, sheet pan, Bunsen burner, ring stand, skillet, beef strips, bell pepper, onion, condiments, access to oven

Lesson Performance Task/Assessment:

This lesson is best performed with a small class so that students can see and smell the differences during the cooking demo. Students can take turns cooking strips of beef and vegetables to see what effect time and temperature have on browning. Students will be asked during the demo to explain the changes they are seeing take place.

Lesson Relevance to Performance Task and Students:

The demo rehashes the different basic divisions of chemical reactions and can be a lead-in to discussion of more complex reaction types.

Anticipatory Set/Capture Interest:

Students are always interested in eating in class. Additionally, videos explaining the science can be shown before the lesson or during the bread-making process.

Guided Practice:

Students will be walked through the basics of the chemical reactions and the process of bread making.

Independent Practice:

Students can cook the beef and vegetables to their liking while being sure to show the process of browning and caramelization.

Remediation and/or Enrichment:

IEP's will be supported. The more complex parts of these reactions can be broken down thusly:

- Fermentation: Sugar → Carbon dioxide + alcohol
- Maillard Reaction: Sugar + amino acid → flavor and aroma compounds
- Caramelization: Sugar → water + flavor and color compounds

For enrichment, study of the intermediate reactions and bond rearrangement can be studied.

Check(s) for Understanding:

Can these reactions happen concurrently?
What are other examples of these reactions?
Can you think of examples of these reactions outside of the kitchen?

Closure:

Students will get to taste the effects of all these reactions in their sandwiches. Unleavened bread and beef cooked without undergoing a Maillard reaction (ex.: shabu-shabu) can be provided for comparison.

Possible Alternate Subject Integrations:

Biology, Microbiology

Teacher Notes:

- Video clips from shows such as "Good Eats" are excellent supporting material for this lesson.
- Chicken can be easily substituted for beef.
- This bread recipe can be made during one 90 minute class: http://www.myrecipes.com/recipe/italian-bread-10000000701035/
- While bread is rising/baking, cook the meat and vegetables in a small iron skillet over a Bunsen burner with a small amount of oil.
- Two informative handouts:
  - http://class.fst.ohio-state.edu/fst605/605p/Maillard.pdf
  - http://www.rsc.org/images/BreadChemistry_tcm18-163980.pdf