

JOHN JAY COLLEGE OF CRIMINAL JUSTICE, CUNY
445 W. 59th St., New York NY 10019
SYLLABUS FOR
“THE CHEMISTRY OF COOKING:
FROM CHEMICALS IN THE KITCHEN TO MOLECULAR GASTRONOMY”

Professor: Chijioke Okeke, Chrissy Michaels

Semester: Summer

Course Code: CHE:126

Course Section: 01

Classroom: Lecture: 3318, Lab: 4331 NH

Class time: 10:00am – 1:00pm

Professor’s office: 03.61

Office Hour: Email to Schedule

Professor’s phone and e-mail: cokeke-Ekpe@jjay.cuny.edu ; cmichaels@jjay.cuny.edu

Course Prerequisite: none

Course Description: During this Chemistry of Cooking class, the hands-on approach gives students a chance to figure out culinary mysteries. This class is designed to look at cooking from a scientific basis. Students will do edible experiments and look at the science behind it. Not only will chemical principles be examined, but also biochemical, biological, microbiological, and some physics. Students will learn methods of scientific investigation and will be able to understand the cooking process i.e. chemical reactions occurring between components in defined food systems.

Learning Outcomes: Students will:

1. Evaluate evidence and arguments critically or analytically.
2. Produce well-reasoned written or oral arguments using evidence to support conclusions.
3. Identify and apply the fundamental concepts and methods of a discipline or interdisciplinary field exploring the scientific world
4. Demonstrate how tools of science, mathematics, technology, or formal analysis can be used to analyze problems and develop solutions.
5. Understand the scientific principles underlying matters of policy or public concern in which science plays a role.

Required Text/s: There is no required text, however the following books are recommended:

1. “Kitchen science explained, What Einstein told his cook”, Robert L. Wolke, **2002**, Ed. W. W. Noton and company
2. “Further edventure in Kitchen Science, What Einstein told his cook, 2”, Robert L. Wolke, **2005**, Ed. W. W. Noton and company
3. “Molecular Gastronomy, Exploring the Science of Flavor”, Hervé This, **2006**, Ed. Columbia Univrsity Press.
4. “On food and Cooking, the science and lore of the kitchen”, Harold McGee, **2004**, Ed. Scribner.

Additional reading:

<http://www.slideshare.net/Chemrcwss/c24-the-chemistry-of-cooking>

<http://www.slideshare.net/smartask27/food-chemistry-i>

<http://www.slideshare.net/smartask27/food-chemistry-ii>

<http://www.slideshare.net/c121401w/carcinogens-in-cooked-meat>

<http://www.slideshare.net/cookbooks/deep-cooking>

Policy on Attendance, Etiquette, and Participation: Students enrolled in this course are *required* to attend all lecture and laboratory sessions of the section for which they registered. There are two lecture sessions per week or one lecture and one laboratory session per week. Justified absences are limited to extraordinary circumstances and written documentation is expected. Attendance, enthusiasm, and active class participation are observed, recorded, and reflected in the student's final grade. Students missing more than 30 minutes of a session will be counted as absent.

The Writing Center: The Writing Center is a service that provides free tutoring to students of John Jay. The Center has a staff of trained tutors who work with students to help them become more effective writers, from planning and organizing a paper, to writing and then proofreading it. The Writing Center is a valuable resource for any student of writing, and I encourage you to use it. If you are given a Referral form to the Writing Center, you must attend to get further instruction on the specific items addressed on the form. This is not optional.

Plagiarism: Plagiarism and cheating are violations of CUNY's policy on academic integrity. By registering in this course, you are promising to abide by all the requirements stated in this policy. Students in breach of this policy are liable to severe penalty, including disciplinary action. See also pp. 44-5 of the JJC Undergraduate Bulletin for further explanation.

Assessment: During the semester, you will be asked to complete all laboratory sessions. After each session, you will write a lab report and answer questions related to the experiment. This assessment will be graded. The lab grades will count for 30% of your final grade. These lab reports will be graded biweekly. Each lab work (pre and post lab questions) will count for 5% of the final grade.

Exams: There will be a midterm exam and a final exam on the course material. The midterm and final exams will count for 40% of your final grade.

A final poster presentation will count for 20% of your final grade.

Participation: participation during in-class discussions about your homework experiments will count for 10% of you final grade.

SCHEDULE OF CLASSES

Wednesday May 28th

(2 lectures)

Introduction to some mathematical principles (metric system, measurements, significant figures) and to some chemistry principles *i.e.* the four basic food molecules: water, lipids, carbohydrates, proteins.

This week will focus on the description of four classes of chemical compounds (water, lipids, carbohydrates, proteins) and their importance in food and cooking. The following scientific principles will be examined in relation to cooking. The physical states of water, the acidity of water, the miscibility of fats and water, fats and heat, saturated and unsaturated fats, emulsifiers, sugars, oligosaccharides, polysaccharides, amino acids and peptides, protein structure, proteins in water, protein denaturation, enzymes.

Homework:

The flavors of caramelized sugars: Mix ½ cup table sugar and 2 Tablespoons water and heat until the sugar boils and turns light brown. Allow the mixture to cool on a greased tray. Taste the final product. Write down your observations.

Reading:

- 1- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 15 pp 792-809
- 2- <http://www.worldofmolecules.com/foods/>

Monday June 2nd

(2 lectures)

In class discussion of Homework given in week one.

Continuation of the introduction to chemical principles.

Examination of the chemicals used in the kitchen and how they work: salt (salt and the body), baking soda, baking powder, sour powder, cream of tartar, vanilla extract, MSG (monosodium glutamate) and antioxidant agents. We will also look at harmful chemicals produced while cooking processing (polyaromatic hydrocarbons, nitrosamines, saturated fats) and why they can be health threatening. Lastly, we will focus on some additives and colorants.

Homework: Hard boil 2 eggs one by simply putting the egg in boiling water, the other by constantly rolling the egg around. Cut the eggs in half. Note the position of the yolk. In class discussion.

Reading:

- 1- "Kitchen science explained, what Einstein told his cook", Robert L. Wolke, Ed. W.W. Norton and company, chapter 3, pp 97-109 and 114-116
- 2- <http://www.slideshare.net/c121401w/carcinogens-in-cooked-meat>
- 3- <http://chemistry.about.com/od/foodcookingchemistry/a/bha-bht-preservatives.htm>
- 4- <http://www.understandingfoodadditives.org/pages/Ch2p4-1.htm>

Wednesday June 4th

Lab 1: “Custard: the chemistry behind the egg-liquid mixture and Caramel Popcorn: sugar at different stages of formation while making caramel.” We will prepare a crème caramel and look at the chemistry behind it. We will also observe “caramelization” from the heating of sugars in water.

Monday June 9th (2 lectures)

The physiology of flavor: We will look at the different biological processes involved in taste. The following topics will be covered: How we detect taste and how we detect aromas. All different tastes will be examined and specifically the newly discovered taste: Umami. The biology of papillary cells will be explained. Finally we will inspect how salt and temperature affect taste.

The second part of the lecture centers on eggs. Egg biology and chemistry will be examined. We will then focus on the chemistry of egg cooking: how protein coagulation explains why eggs get hard and custards thicken. We will examine the chemistry of egg flavor. We will look at how the egg proteins stabilize foams and the difference between white foams versus yolk foams. Finally we will look into egg safety and the salmonella problem.

Homework: Heat the tip of your tongue up to 95° F (35° C) and then cool it down to 41° F (5° C). Record your tastes. In class discussion.

Reading on taste:

- 1- http://www.edinformatics.com/math_science/science_of_cooking/taste_molecules.htm
- 2- http://www.scienceofcooking.com/about_taste.htm
- 3- “Molecular gastronomy, exploring the Science of Flavor”, Herve This, Ed. Columbia University Press, pp 86-108 and 161-163.

Reading on eggs:

- 1- “On food and Cooking, the science and lore of the kitchen”, Harold McGee, Ed. Scribner, Chapter 2 pp 68-115
- 2- <http://www.incredibleegg.org/egg-facts/egg-safety/eggs-and-food-safety>

Wednesday June 11th

Lab 2: Eggs Benedict. Poached eggs explore the slight unraveling of proteins and coagulation. The hollandaise sauce shows mastery of emulsification and the dispersion of fat droplets in a viscous solution. We will observe how protein coagulation explains why eggs get hard and the yolk thickens. We will observe how lecithin, a monoglyceride found in egg yolks, is used as an emulsifier *i.e.* prevents the separation of fats and water.

Monday June 16th (2 lectures)

This week will focus on meat and fish. We will at the following topics: 1) The structure of muscle tissue and how they are related to the meat texture and flavor. 2) The chemistry behind aging meat. 3) The chemistry behind cooking meat: the denaturation of myosin and myoglobin. 4) We will explain scientifically the color of meat cooked over charcoal 5) Finally we'll look into the controversies in modern meat production

The second part of the lecture will focus on fish: We will first look at the problematic between seafood and health: health benefit and health hazard. The anatomy and qualities of fish will then be described. We will look into the chemicals responsible for fish flavor, aroma (trimethylamine oxide, trimethylamine and dimethylamine) and color (beta carotene and myoglobin). We will examine how heat transform rawfish's flavor and texture and the processes behind drying and salting fish We will then focus on shellfish, their special qualities and fish eggs.

Homework: Literature search on the Maillard reaction. In class discussion and case study.

Reading on meat:

- 1- "Kitchen science explained, what Einstein told his cook", Robert L. Wolke, Ed. W.W. Norton and company, chapter 3, pp 136-145.
- 2- "Further adventures in kitchen science, what Einstein told his cook 2", Robert L. Wolke, Ed. W.W. Norton and company, chapter 7, pp 320-324.
- 3- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 2 pp 124-125; 127-135; 142-147; 148-164.

Reading on fish:

- 1- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 2 pp 183-184; 187-194; 204-206; 208-211; 218-242.
- 2- "Kitchen science explained, what Einstein told his cook", Robert L. Wolke, Ed. W.W. Norton and company, chapter 5, pp 157-165.
- 3- "Kitchen science explained, what Einstein told his cook", Robert L. Wolke, Ed. W.W. Norton and company, chapter 6, pp 239-245; 248-251; 264-265.
- 4- "Molecular gastronomy, exploring the Science of Flavor", Herve This, Ed. Columbia University Press, pp 164-166.

Wednesday June 18th

Lab 3: Surf & Turf: During this lab we'll observe how heat modifies the texture and color of raw sea food. For instance, the chemical astaxanthine is released upon cooking shrimps giving them their distinctive pink color. Without astaxanthine, your shrimps would not turn pink! We will also explore the Malliard reaction on meat.

Monday June 23rd

The science of sauces:

We will first look at sauces that are thickened with flour and starch. We'll start by looking at the nature of starch (linear amylose and bushy amylopectin). We will examine the behavior of starch in hot water and the science behind thickening and thinning. Finally the influence of some chemical compounds (salt, sugar, acid, proteins and fats) on starch sauces will be explained.

We then will look into emulsions i.e. sauces thickened with droplets of oil or water. The nature of emulsions will be explained as well as the physics behind their formation (overcoming the force of surface tension). We will also look into the properties of emulsifiers. There will be an in class case study: mayonnaise and how the elements in egg plasma are responsible for the egg's yolk emulsifying effect.

The final sauces we will examine are stocks. We will look at the reason behind the contribution of bones *i.e.*, how gelatin and other proteins thicken stocks. Finally the concept of spherification will be explained.

Homework: Prepare two vinaigrettes: one with oil (3 parts) vinegar (1 part) salt and pepper, the other with oil vinegar salt paper and a tea spoon of French mustard. Record your observations. In class discussion.

Reading:

1-<http://www.finedininglovers.com/stories/science-sauces-mayo-how-to/>

2-<http://www.thekitchn.com/food-science-why-did-my-sauce-46045>

3-<http://www.exploratorium.edu/cooking/eggs/hollandaise-pop.html>

4-<http://www.exploratorium.edu/cooking/icooks/3-24-03.html>

5- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 11 pp 591-639.

Wednesday June 25th

Midterm Exam

Monday June 30th

Lab 4: Blueberry pancakes with homemade jam and whipped cream. We will look at the chemistry and physics behind the use of blue corn meal and the formation of gluten network through the making of the batter. The jam will explore the use of pectin to form gels with sugar and viscous solutions and the whipped cream will explore how air is trapped between fat molecules giving this creamy topping lift and body.

Wednesday July 2nd

The basic structure of dough, batters and their products (gluten, starch, gas bubbles, fats) will be discussed. We will compare yeasts and chemical leavenings.

Next we will look at the chemistry and physics behind the production of bread: ingredients, mixing and kneading, fermentation, baking and the role of steam. Finally we'll look at how to

improve dough by investigating the protein bonds that form its glutenous network and how the mechanical behavior of bread resembles that of plastic material.

Next we'll look into the structure and characteristics of cheeses. How cheeses are made and produced, what chemical reactions happen during cheese processing.

Reading on dough and batter:

1- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 10 pp 521-571.

2- "Molecular gastronomy, exploring the Science of Flavor", Herve This, Ed. Columbia University Press, pp 230-233.

3-http://www.exploratorium.edu/cooking/bread/bread_science.html

4-<http://www.guardian.co.uk/science/blog/2009/nov/26/science-breadmaking>

Reading on cheese:

1) « Molecular gastronomy, Exploring the science of flavor » Hervé This, Columbia University press, 2006, pp 44-46

2) <http://rdo.psu.ac.th/sjstweb/journal/27-1/19casein-micelle.pdf>

Monday July 7th

Lab 5: Macaroni and Cheese. The chemistry of the emulsion of a cheese sauce will be examined, as well as the cooking of starches in pasta. Molecular Gastronomy Experiment. We will also explore spherification through the use of Calcium Chloride and Sodium Alginate to make a "pearl" tomato bruschetta with toast.

Wednesday July 9th

The final week will focus on Sugars and Chocolate and plants. Common sugars, their structure and relative sweetness will be examined: glucose sucrose fructose, lactose. Crystallization and amorphous states concepts will be explained through the description of sugar crystals. Next we will discuss about the relationship between Sugars and health and about the controversy surrounding high fructose corn syrup.

We will then look at chocolate. We will describe the history of chocolate, the composition of dried fermented cacao beans and of dark and milk chocolates.

The special qualities of chocolate will be examined: Consistency and appearance and how cocoa butter is produced. The chemicals involved in chocolate flavor will be described as well as the process of tempering chocolate (or the art of crystallization). Lastly, we will look at the health effects of chocolate (Fats and antioxidants, Caffeine and Theobromine) and why some people "crave" chocolate.

Finally, we will look into edible plants. We will look at plant structures, cells, tissues and organs. The toxins and beneficial chemicals in plants will be discussed. We will also discuss about genetic engineering and food. The chemicals involved in the color and taste (touch, irritation and

aroma) of plants will be examined. Finally we'll explain how heat affects the qualities of fruit and vegetable, the processes involved during fermentation and the science behind canning and sugar preserves (the role of copper in hardening preserves).

Homework: Color and freshness. Cut five slices from an avocado (or a banana). Leave one in the air, one in the fridge, one in the air but sprinkled with lemon juice, one in the air but sprinkled with vinegar, the last one in the air sprinkled with vitamin C. Record your observations after a few hours. In class discussion.

Reading on sugar and chocolate:

- 1- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 12 pp 652-712.
- 2- "Molecular gastronomy, exploring the Science of Flavor", Herve This, Ed. Columbia University Press, pp 319-327.

Reading on plants:

- 1- "On food and Cooking, the science and lore of the kitchen", Harold McGee, Ed. Scribner, Chapter 5 pp 253-270; 270-299.
- 2- "Molecular gastronomy, exploring the Science of Flavor", Herve This, Ed. Columbia University Press, pp 56-58.
- 3- "Further adventures in kitchen science, what Einstein told his cook 2", Robert L. Wolke, Ed. W.W. Norton and company, chapter 6, pp 147-201.

Monday July 14th

Lab 6: Chocolate Velvet Mousse. Because of its cocoa butter content, chocolate blends well with other fats and oil. For this final lab we will see how cooking is creative. This new recipe for chocolate mousse utilizes olive oil rather than cream or butter. This silky mousse is served in the famous Manhattan restaurant, Marichu. Blue Cheese Chocolate Truffles. We will explore how the complex flavors in blue cheese and dark chocolate work together to create a unique truffle.

Wednesday July 16th

Final Poster Presentation Proposals due. Must be submitted via email to Chef at cmichaels@jjay.cuny.edu in order to receive credit. Late submissions will not be accepted.

Final examination and Poster Presentation July 21st

Final exam followed by presentation of a dish from all students. Students will bring a dish which they will have prepared at home and was approved in advance. They will give a poster presentation of the chemistry involved behind the preparation of their dish.

Last Day to Withdraw without Academic Penalty: TBD.

The final grades possible and their significance are listed below:

A	93.0%-100%	EXCELLENT
A-	90.0-92.9%	EXCELLENT
B+	87.0%-89.9%	VERY GOOD
B	83.0%-86.9%	VERY GOOD
B-	80.0%-82.9%	VERY GOOD
C+	77.0%-79.9%	SATISFACTORY
C	73.0%-76.9%	SATISFACTORY
C-	70.0%-72.9%	SATISFACTORY
D+	67.0%-69.9%	POOR (PASSING, BUT TOO MANY CAN LEAD TO DISMISSAL)
D	63%-66.9%	POOR (PASSING, BUT TOO MANY CAN LEAD TO DISMISSAL)
D-	60.0%-62.9%	POOR (PASSING, BUT TOO MANY CAN LEAD TO DISMISSAL)
F	0.0%-59.9%	FAILURE (NOT ERASED WHEN COURSE IS RETAKEN AND PASSED)
WU		Withdrew Unofficially