Chem 130L: Science of Cooking (NS)
Syllabus, Summer Session 2, 2021

(Soft) Prerequisite: CHEM99D or equivalent.

Days and time: MW: 5:00-6:15pm; TTh: 7:00-8:15pm
Location:
  • Monday & Wednesday: synchronous (or asynchronous) lecture.
  • Tuesday & Thursday: synchronous (or independent) lab.

Instructor: Patrick Charbonneau
Office hour: M 4:00-5:00pm (or by appointment), via Zoom.

Chef: Todd Ohle
Office/lab hours: TTh 30 mins before and after lab (or by appointment), via Zoom.

Teaching assistant: TBA

Course Description:
Gastronomy is increasingly popular, and its main practitioners are stars. But Ferran Adrià, Joan Roca, and Grant Achatz share more than fame. They use science to create gastronomic art that challenges our culinary experience. Traditional techniques used to be followed blindly; they are now deconstructed to bring them to new heights. In this course we explore the science that lies behind the new frontier in taste.

Main course objectives:
  ● Understand some of the science involved in cooking.
  ● Discover the tools and technologies used by world-leading chefs for their creation.

Secondary objectives:
  ● Develop an interest in culinary creation.
  ● Educate one’s sense of taste.

Students will handle (and taste) food, in order to consolidate the scientific learning. ANY FOOD ALLERGY MUST BE DECLARED ON THE FIRST DAY OF CLASS. Specialized cooking supplies and material will be mailed before the start of the semester. Standard cooking supplies (cream, flour, sugar, etc) and material (see list below) should be obtained on one’s own.

Standard supplies and material should be available on time for the lab session, or earlier, when specified in the lab description.

**Standard Material List**
Various supplies and pieces of equipment will be mailed to you before the start of the class. You are additionally expected to have access to the (non-exhaustive) list of pieces of equipment:
- wooden spoon;
- small pot;
- whisk;
- (high heat) spatula;
- pie tin or heat proof dish;
- strainer;
- slotted spoon;
- small cups (any small vessel that can hold about 12 oz of liquid);
- immersion blender;
- baking ramekin/dish;
- baking sheet;
- non-stick pan;
- Ziploc-type bags.

*If getting a hold of all or some of these is a hurdle to class participation, please contact the instructors ahead of the first lecture.*

**Grading Scheme**
Online reading quizzes: 10% (Due before Monday class).
Lab worksheets: 15% (Due at the end of lab, most Tuesdays and Thursdays).
Assignments: 15% (Due by the end of TA office hour, roughly every Wednesday).
Midterm paper about a science-based culinary creation: 30% (Due date: June 8, 2020).
Final group presentation (Exam Period): 30%.

**Absence Policy**
No late assignment or quiz will be accepted for credit regardless of the nature of the absence.

**Community Standard**
This course expects participants to follow the Duke Community Standard
Course Outline

Topic 1:
Lecture: Monday, June 28, 2021
Overview of the course. Introduction, math review, and historical and scientific context.

Topic 2:
Lecture: Tuesday, June 29, 2021

Kitchen: Thursday, July 1, 2021
Introduction to cooking: basic hygiene, security, utensils. Crystallization of sugar, candies.


Topic 3:
Lecture: Wednesday, June 30, 2021
Components of food: mixtures and intermolecular forces. Types of mixtures and basics of aromas explained in the context of intermolecular forces including notions of saturation and equilibrium.

Kitchen: Tuesday, July 6, 2021
Fresh Cheese.

Reading: On Food and Cooking: Chapter 1: “Milk Biology and Chemistry” p. 16-21 (print) & “Cheese” (only first 6 subsections) p. 51-66 (print); Chapter 8: “Cooking with Herbs and Spices” p. 397-401 (print).

Topic 4:
Lecture: Wednesday, July 7, 2021
Viscosity and elasticity: texture and mouthfeel.
Demystifying texture by explaining how the chewy, soft, runny, and thick sensations we experience result from the elasticity and viscosity of foods and sauces.

Kitchen: Thursday, July 8, 2021
Thickeners and gels.

Reading: On Food and Cooking: Chapter 5: “The Composition and Qualities of Fruits and Vegetables” (only first 2 subsections) p. 261-266 (print) & “Cooking Fresh Fruits and
Vegetables” (only the “Texture” subsubsection of the first subsection) 282-284 (print); Chapter 11: “Solid Sauces: Gelatin Jellies and Carbohydrate Jellies” & “Sauces Thickened with Flour and Starch” p. 605-620 (print).

**Topic 5:**
*Lecture: Monday, July 12, 2021*
Gelation and polymers. Physical process of gelation, chemistry and physics. Chemical gels, e.g. using transglutaminase; physical gels, e.g. alginate, gelatin, eggs; how gelation can be tuned. Spherification. Pectin. Advanced gelation agents.

*Kitchen: Tuesday, July 13, 2021*
Gels and gummies.

*Reading:* On Food and Cooking: Chapter 3: “Cooking Fresh Meat: The Principles” (only last 3 subsections) p. 149-154 (print); Chapter 4: “The Anatomy and Qualities of Fish” (only middle 2 subsections) p.191-193 (print); Chapter 5: “Preserving Fruits and Vegetables” (only “Sugar Preserves” subsubsection) p. 296-299 (print).

**Topic 6:**
*Lecture: Wednesday, July 14, 2021*
Dispersions in the Kitchen. Microscopic analysis of special mixtures that form when droplets of air, liquid, or water are infused in a liquid of choice.

*Kitchen: Thursday, July 15, 2021*
Mousses, mayo, meringue

*Reading:* On Food and Cooking: Chapter 5: “Cooking Fresh Fruits and Vegetables” (only subsubsection “Foams and Emulsions” in the “Pulverizing and Extracting” subsection) p. 289 (print); Chapter 11: “Sauces Thickened with Droplets of Oil or Water: Emulsions” p. 625-639 (print); Chapter 1: “Unfermented Dairy Products” (only “Cream” subsection) p. 27-32 (print); Chapter 2 “Egg Foams: Cooking with the Wrist” (only first 6 subsections) p. 100-109 (print).

**Topic 7:**
*Lecture: Monday, July 19, 2021*
Diffusion. Basic concepts of random diffusion applied to the diffusion of heat (cooking), diffusion of water, and diffusion of particles.

*Kitchen: Tuesday, July 20, 2021*
Spherification and cake.


**Topic 8:**
**Lecture: Wednesday, July 21, 2021**
Proteins and enzymes. Introduction to proteins and their building blocks amino acids. Modification of cooking conditions can alter the proteins in food to provide new textures and flavors.

**Kitchen: Thursday, July 22, 2021**
Custards and soufflés.


**Topic 9:**

**Lecture: Monday, July 26, 2021**
Flavors and flavor modification. Sense of taste, tricking the sense of taste, and altering flavors using browning reactions and texture manipulation.

**Kitchen: Tuesday, July 27, 2021**
Hamburgers -- caramelized onions and browned meat.

Readings: *On Food and Cooking*: Chapter 14: “Browning Reactions and Flavor” p. 777-780 (print); Chapter 12 “The Nature of Sugar” (only the "Sugar Substitutes" subsection) p. 659-663 (print); Chapter 3: “Cooking Fresh Meat: The Principles” (only first 2 subsections) p. 147-149 (print); Flavor p. 270-275; Chapter 6 “Seaweed” (only the “Seaweed and the Original MSG” box) p. 342 (print); Chapter 8: “The Nature of Flavor and Flavorings” and “The Chemistry and Qualities of Herbs and Spices” (except last subsection) p. 387-395 (print) & “A Survey of Temperate-Climates Spices” (only the “Chilis” subsection) p. 418-420 (print).

**Topic 10:**

**Lectures: Wednesday, July 28, 2021**
Bacteria and yeasts. Bacterial multiplication, limit population, resource depletion, chemotaxis. Bacteria and their role in transforming food, for better or for worse.

**Kitchen: Thursday, July 29, 2021**

Readings: *On Food and Cooking*: Chapter 10: “Dough and Batter Ingredients” and “Breads” p. 531-550 (print) & “Pastries”, “Cookies” and “Pasta, Noodle and Dumplings” p. 560-579 (print); Chapter 9: “Legumes” (only the “Fermented Soybean Products” subsubsection of the “Soybeans and Their Transformations” subsection) p. 496-500 (print); Chapter 13: “The Nature of Alcohol” (only the first subsection) p. 715-716 (print); Chapter 1: “Yogurt” p. 47-51 (print).
**Topic 11:**  
*Lecture: Monday, August 2, 2021*  
Heating, cooling and tempering. Critical temperatures for phase transitions (egg, meat, chocolate). Manipulating temperatures for optimal ice cream physical properties.

Readings: *On Food and Cooking*: Chapter 1: “Unfermented Dairy Products” (only the “Ice Cream” subsection) p. 39-44 (print); Chapter 12: “Chocolate” p. 694-712 (print).

**Kitchen: Tuesday, August 3, 2021**  
Chocolate tempering.

**Topic 12:**  
*Lecture: Wednesday, August 4, 2021*  
Flavor Preferences. Biological explanation for preferences of particular flavors, and a discussion of the interaction between humans, animals, and the plants that produce food for humans.

**Kitchen: Friday, August 5, 2021**  
Chef office hour to discuss and work on final project.

**Final Exam:**  
Group presentations scheduled August 6-8.
Instructor Bios

Professor Patrick Charbonneau
Professor Charbonneau received a PhD in chemical physics from Harvard, and joined the chemistry faculty at Duke in 2008, where he studies the theory of soft materials (see https://chem.duke.edu/faculty/patrick-charbonneau). A native of Montreal, he is told to have loved beets and raspberries from an early age. His interest in food has since broadened somewhat.

Chef Todd Ohle
Todd Ohle began his culinary career at The Culinary Institute of America, and subsequently worked in various restaurants and as a private chef in Miami Beach. In 1999, Todd and his wife moved to North Carolina, where in 2001, he became executive chef at Rocky Top Hospitality. He rose to become Director of Culinary Operations and executive chef of 1705Prime, but was left wanting to spend more time with his two young daughters. In 2008, Todd thus switched course to become the Food and Beverage Director at The Cypress of Raleigh retirement community. In 2016, his daughters now teenagers, Todd realized his dream of opening his own restaurant(s). In 2018, he became VP of Dining Services at the Carolina Meadows retirement community in Chapel Hill.