

## SPU-27

### Science and Cooking: From Haute Cuisine to Soft Matter Science Fall 2015, T/Th 1-2.30, Science Center C



This course will discuss concepts from the physical sciences that underpin both everyday cooking and haute cuisine. The content, including the delicious and edible (!) labs, have been developed in collaboration with the El Bulli Foundation in Spain. Each week a world-class chef will visit and present their remarkable culinary designs. The chefs include Andoni Aduriz (*Mugaritz*), José Andrés (*minibar, Jaleo, The Bazaar, ThinkFoodGroup*) Joanne Chang (*Flour Bakery, Myers and Chang*), Jim Lahey (*Sullivan Street Bakery*), Mark Ladner (*Pasta Flyer, Del Posto*), Josep Roca (*El Celler de Can Roca*), Bryan and Michael Voltaggio (*Ink, AGGIO, VOLT*), Tara Whitsitt (*Fermentation Truck*). There will also be demos and lectures by other leaders in the field, including authors Harold McGee (*On Food and Cooking, Keys to Good Cooking*), Nathan Myhrvold (*Modernist Cuisine*), and food scientist Dave Arnold (*Booker and Dax, Cooking Issues*). This year, the Top Chef team will also visit us for the Science Fair, including Mei Lin, Gail Simmons, and Tom Colicchio.

At the end of the course, students will be able to explain how a range of cooking techniques and recipes work, in terms of the physical and chemical transformations of the food.

#### Instructors

<p><b>Michael Brenner</b> brenner@seas.harvard.edu Pierce Hall 313 Office Hours: TBA</p>	<p><b>Pia Sørensen</b> pia.spu27@gmail.com Pierce Hall 206A Office Hours: TBA</p>
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### Teaching Fellows

<b>Head-TF</b>	Katherine Phillips		
<b>Lab Manager</b>	Mai Nguyen		
<b>Teaching Fellows</b>		Charles Margarit	Hidenori Tanaka
	Sid Venkat	Evan Jones	Lulu Liu
	Mishu Dudata	Sixun Chen	Jon Russell
	Olivia Miller	Andy Shumaker	
	Sören Brandt	Liuchuen Tong	

### Prerequisites

High school physics and chemistry will be useful. Background material will be reviewed using videos developed for the HarvardX class.

### Expectations

You are expected to attend all lectures and lab sections, submit weekly problem sets and lab worksheets, take two midterm exams, and write and present a final research project. The class will have no final exam.

### Lectures

Lectures will be held in **Science Center C on Tuesdays and Thursdays from 1 to 2.30 pm**. Tuesday lectures begin with a 20-minute introduction about the relevant scientific topic, followed by a presentation by a visiting chef who discusses culinary applications of this topic. Thursday lectures are led by the course instructors and go deeper in to the science. A portion of the material covered on Thursdays will be especially designed to prepare you for the week's homework. The lectures will not be video-recorded, but the majority of the science material is available in the form of short videos that were developed for the online HarvardX class. **Note:** out of respect for the chefs, no laptops can be used during their presentations.

### Lab Sections

Sections and labs are combined into a single 2-hour block, at which attendance is required. In the past, this has been the highlight of the course for most students—you will make measurements on recipes that you can then eat! The first half hour of each section will be devoted to a review of scientific concepts. Following this, you will prepare an edible recipe in a team of 2-3 students, and make measurements along the way, to illustrate the concepts discussed in lecture. At the end of each section you are expected to turn in a brief **lab worksheet**. No make-up labs will be offered, but you can drop your lowest score on worksheets and prelabs. Labs take place in a food-safe lab in the **Northwest Building, Level B1, Room 143**. You must sign up for section using the online sectioning tool (a link is available on the course website). The deadline to section is **Monday, September 7th at 11.59 pm**. Sections will begin on

**Thursday September 10th**, and are scheduled throughout the day and evening Thursday-Wednesday. No section changes are allowed after Thursday, September 17th. Section switching due to illness, job-interviews, or similar can be granted in exchange for a dean's or doctor's note on a case by case basis. In special circumstances you may get half-credit for excuses that do not fall within these categories. All section switching *must* be confirmed prior to section by the head-TF.

**Note: The course involves the preparation and (optional) consumption of food. If you have specific food allergies or needs, please be in touch with the course staff to discuss arrangements.**

### Lab work sheet

The lab worksheet is a brief but integral part of lab and contains questions about the experiments, your results, and data analysis. The worksheet is due at the end of each lab section. You are allowed to drop your one lowest worksheet score.

### Homework

Weekly homeworks are due in your TF's homework box on the second floor of the Science Center before start of class on Thursdays. No late problem sets are accepted. You are allowed to drop your one lowest problem set score during the semester.

### Exams

There will be two in-class midterm exams, scheduled on **October 8** and **November 19**. The first midterm covers materials in weeks 1-4, i.e. through Thurs 10/1, and the second midterm covers material in weeks 5-9 (Diffusion-Fermentation). The class has no final exam.

### Final Projects

All students will carry out a practical project in groups within their lab sections to connect some aspect of cooking to science. The results of these projects will be presented at a course-wide science fair, to be held on **Tuesday, December 8th**.

### Grading

The final course grade will take into account the following components:

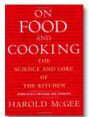

<b>Homework</b>	<b>15%</b>	<b>9 weeks, drop lowest score</b>
<b>Lab worksheet</b>	<b>20%</b>	<b>7 lab worksheets and prefabs (drop lowest score)</b>
<b>Midterm exams</b>	<b>2x20%</b>	<b>2 midterm exams</b>
<b>Final project</b>	<b>25%</b>	<b>Proposal, progress reports, final report, science fair</b>

## HarvardX Videos

Substantial material for this class has been developed in the form of videos for the HarvardX class. This material covers the scientific and cooking concepts in ~10 minute videos – the science videos were made by the faculty teaching the class, and the cooking videos by our visiting chefs (they were often filmed in the kitchens of their restaurants). Watching of these videos is mostly optional, and we recommend that they be used as review and supplementary materials. A small number will be recommended as useful background before lecture, or occasionally assigned as part of solving homework problems. However, the large majority of the material in this course will be covered in lecture and labs. All videos are available on the course website.

## Textbooks

Two texts will be useful for this course. Each week, **recommended, but not required**, readings will be drawn from these books.

	<p><b><i>On Food and Cooking, Harold McGee, Scribner, 2004 (2nd edition)</i></b> <i>On Food and Cooking</i> will significantly enhance your understanding of this subject and serve as a truly invaluable resource and reference, both for this class and beyond. It is available in hard copy at the Coop (new \$40, used \$30) and as an eTextbook (\$25).</p>
	<p><b><i>Science and Cooking: A Companion to the Harvard Course, 2015</i></b> <i>Science and Cooking: A Companion to the Harvard Course</i> is based on the transcripts from the HarvardX science videos. This text serves as a summary of all of the science that is covered in the course. The course will be made available for free from the instructors, details to be announced.</p>

## Additional Texts

More specific texts covering the scientific aspects of cooking, and the basic science, are listed below. Most of these are on reserve in Cabot library – for a complete list see the course website.

The following books cover various aspects of the science contained in the course:

***The Science of Good Cooking, America's Test Kitchen***

***The Science of Cooking, Peter Barham***

***The Science of Chocolate, Stephen T. Beckett***

***The Science of Ice Cream, C. Clarke***

***Cookwise, Shirley Corriher***

***Keys to Good Cooking, Harold McGee***

***The Curious Cook, Harold McGee***

***Modernist Cuisine, Nathan Myhrvold, Chris Young, and Maxime Billet Ratio, Michael Ruhlman***

Several of the guest lecturers have written cookbooks, which may be of interest:

***A Day at El Bulli, Ferran Adrià***

***Made in Spain: Spanish Dishes for the American Kitchen, José Andrés***

***Tapas: A Taste of Spain in America, José Andrés***

***Liquid Intelligence: The Art and Science of the Perfect Cocktail, Dave Arnold***

***Flour: Spectacular Recipes from Boston's Flour Bakery + Café, Joanne Chang***

***Flour, too: Indispensable Recipes for the Café's Most Loved Sweets and Savories, Joanne Chang***

***My Pizza: The Easy No-Knead Way to Make Spectacular Pizza at Home, Jim Lahey***

***My Bread: The Revolutionary No-Work, No-Knead Method, Jim Lahey***

***El Celler de Can Roca, Jordi, Josep, and Joan Roca***

***Sous Vide Cuisine, Joan Roca***

***VOLT ink: Recipes, Stories, Brothers, Bryan and Michael Voltaggio, Ed Anderson***

***Home: Recipes to Cook with Family and Friends, Bryan Voltaggio***

For a more advanced discussion of the scientific topics in the course:

***Physical Chemistry of Foods, Pieter Walstra***

### **Academic Integrity**

Discussion and the exchange of ideas are essential to doing academic work. For assignments in this course, you are encouraged to consult with your classmates as you work on problem sets and labs. However, after discussions with peers, make sure that you can work through the problem yourself and ensure that any answers you submit for evaluation are the result of your own efforts. In addition, you must cite any books, articles, websites, lectures, etc that have helped you with your work using appropriate citation practices. Similarly, you must list the names of students with whom you have collaborated on problem sets.

### **Accommodations for Students with Disabilities**

Students needing academic adjustments or accommodations because of a documented disability must present their Faculty Letter from the [Accessible Education Office](#) (AEO) and speak with the professor by the end of the second week of the term, **September 12th**. Failure to do so may result in the Course Head's inability to respond in a timely manner. All discussions will remain confidential, although Faculty can contact the AEO to discuss appropriate implementation.

## Schedule at a Glance

### Week 0: Introduction

**Th 9/3** Introduction, overview of the course

### Week 1: Components of Food and Historical Background

**T 9/8** A history and introduction to science and cooking

Guest speakers: Harold McGee (*On Food and Cooking*), Dave Arnold (*Cooking Issues, Booker and Dax*)

**Th 9/10** Food components; Moles; Scientific dissection of Nestle Toll House Chocolate Chip cookie Recipe

### Week 2: Energy, Temperature, Heat

**T 9/15** Myths of cooking pasta

Guest speaker: Mark Ladner (Pasta Flyer, Del Posto)

**Th 9/17** Energy, calorimetry, molecular bonds, heating and temperature

### Week 3: Phase Transitions

**T 9/22** The science of sugar, crystallization

Guest speaker: Joanne Chang (Flour Bakery and Café)

**Th 9/24** Phase behavior macroscopically and microscopically, temperature, pressure, phase diagrams, violations to phase diagrams.

### Week 4: Elasticity

**T 9/29** Elasticity, gluten networks

Guest speaker: Jim Lahey (Sullivan Street Bakery, NYC)

**Th 10/1** Mouthfeel, texture, molecular origins of elasticity, gels, steak, tofu, flan

### Week M1: Review and Midterm

**T 10/6** Review

**Th 10/8** MIDTERM (covers through elasticity, 10/1)

### Week 5: Diffusion and Spherification

**T 10/13** Gelation, spherification, diffusion and infusion

Guest speaker: Andoni Aduriz, Ramon Perisé (Mugaritz)

**Th 10/15** Gelation, cross-linking, polymers, spherification, random walk

### Week 6: Heat Transfer

**T 10/20** Heat transfer introduction

Guest speaker: Josep Roca (El Celler de Can Roca)

**Th 10/22** Heat transfer, transition temperature, diffusion of heat, baking a cake

### Week 7: Viscosity and Polymers

**T 10/27** Viscosity introduction

Guest speaker: José Andrés (minibar, Jaleo, The Bazaar, ThinkFood group)

**Th 10/29** Viscosity, molecular origin, role of temperature, thickeners and food additives

**Week 8: Emulsions and Foams**

**T 11/3** Emulsions and Foams introduction

Guest speaker: Bryan and Michael Voltaggio (Ink, VOLT, AGGIO, etc)

**Th 11/5** Emulsions, surfactants, elasticity of elastic materials, mayonnaise, culinary foams

**Week 9: Enzymatic Reactions and Fermentation**

**T 11/10** enzymatic reactions

**Th 11/12** chemical processes in microbes, fermentation, yeast

**Week M2: Fermentation, Review and Midterm**

**T 11/17** Cooking with fermentation

Guest speaker: Tara Whitsitt (Fermentation Truck)

**Th 11/19** Midterm # 2 (Covers Week 5-9)

**Week 10: Modernist Cuisine**

**T 11/24** Modernist cuisine

Guest speaker: Nathan Myhrvold (Modernist Cuisine)

**Th 11/26** Thanksgiving

**Week 11: Final Wrap-Up**

**T 12/1** Candy

**Th 12/3**

**SCIENCE FAIR: Tuesday, December 8th**

**Guests: Mei Lin, Gail Simmons, Tom Colicchio (Top Chef)**