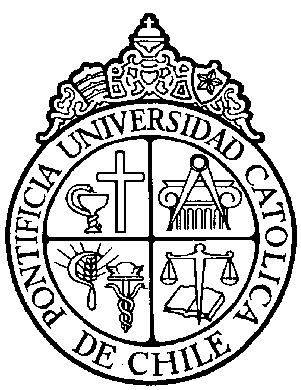
**COURSE SYLLABUS**

**PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE**

**SCHOOL OF ENGINEERING**

**Department of Chemical and Bioprocess Engineering**

**www.ing.puc.cl/iiq**



COURSE TITLE : **INTRODUCTION TO GASTRONOMIC ENGINEERING**

CODE : IIQ-2930

CREDITS : 10

SEMESTRER : II-2017

MODULES : THURSDAYS: 5 & 6 (15:30 to 18:20); Lecture room DIQB.

PREREQUISITES: IIQ1003 or IMM1003 or FIS1523.

LANGUAGE : **ENGLISH** **(Slides presented in lectures, readings, quizzes and final term project)**

LECTURER : José Miguel Aguilera

ASSISTANTS : Anaïs Lavoisier, Dra. Mariel Farfán

RESEARCH CHEF: Maike Siegel

IMPORTANT NOTE: **This course cannot be dropped**

1. BACKGROUND

Basically, we eat structures that taste good and there is a lot of science and engineering behind. Food structures take the form of sponges, creamy liquids, emulsions, foams, gels, cellular solids, fibrous materials, etc., and are subjected to mixing, heating, freezing, drying, etc., before being consumed. These tasty structures convey the nutrients needed for a good life. Gastronomic Engineering is largely applying the fundamentals, methods and tools of physics and food engineering to the understanding of culinary practices, and the design and elaboration of delicious gastronomic products. Our Gastronomic Engineering Unit is a unique space for the co-creation and inquisitive research on food structures and consists of an experimental kitchen headed by a scientific chef and two support laboratories (food engineering and food materials science).

1. OBJECTIVES

The objective of this course is to present a novel vision of the science and engineering residing within our food and some dishes. The course addresses how food structures are produced, preserved and transformed by processing and culinary techniques. Emphasis will be on how these transformations are based on scientific and engineering principles, which will be explained using as examples the main processeses of food production and some culinary techniques. It will be highlighted that food processing continues in the mouth and in the digestive system, and its connections with the brain (neuro-gastronomy). We will also critically discuss some modern trends in food, nutrition and gastronomy and the social implications that are affecting our quality of life. Also included are demonstrations of preparation and evaluation of appetizing and healthy products by a chef researcher. The audience is undergraduate students who have enough curiosity to learn about the science behind our food and dishes, are interested in understanding of gastronomy and dare to innovate in their kitchens. This is a course dedicated to a better understanding the world of foods and how to enrich our quality of life and that of others.

1. COMPETENCIES AND OUTCOMES

Competencies

|  |  |
| --- | --- |
| Competencies (desired knowledge, skills and behaviors) | Outcomes (what will be able to do in a measurable way) |
| Handle basic concepts of cellular structures in plants and animals and their role in food and nutrition. | Describe important elements and the major molecular components in foods, and relate them to some aspects of nutrition. |
| Apply basic concepts of physical chemistry to processes leading to formation of food structures. | Correctly use these concepts to food processes. Explain their role in phenomena. |
| Apply basic concepts of engineering (heat & mass transfer, diffusion, etc.) to processes leading to formation of food structures. | Correctly use these concepts in food processes. |
| Apply basic concepts of food materials science (Tg, mechanical diagrams) and microscopy to processes leading to formation of food structures. | Appropriately apply these concepts to specific foods and dishes. |
| He is able to apply some techniques to evaluate food properties. | Interprets diagrams, graphs and derived parameters. |
| Understands the physics involved in the formation of foams, gels, emulsions, expanded and extruded foods. | Apply these concepts to conceptualize new foods and apply them in term project. |
| Understand several processes in food and cooking from the scientific-technological point of view. | Apply these concepts in practical situations, to interpret recipes, and understand how food products are made. |
| Understand the basic physiological phenomena related to sensory perception and digestion as applied to foods. | Apply these concepts to specific food components and meals. |
| Undertake a project in autonomous form, perform the necessary experiments and present results. | Have hands-on experiences on product development through laboratory work and practical application of science principles. |
| Perform bibliographic searches related to food and gastronomy; prepare reports (video) and make presentations. | Use of appropriate databases.  Identify food topics in scientific journals. |

1. CONTENTS

**Lecture 1.** Molecules and structures in food and our body. Proteins, carbohydrates, lipids, water and others. Concept of food matrix and relation with nutrients. Elements that make up food at a microscopic level and its dimensions. Microscopy and imaging techniques for examining food products. In class: *Capsule 1 – Food components and Video 2016; images MicroCT.* *Demo: Experimental kitchen and stereomicroscope; Laboratory and optical microscope.*

**Lecture 2**. Size of basic food structures. Characteristics of food structures provided by nature (meat, fruit, vegetables, starch, etc.), obtained after processing (frozen, dried, freeze-dried, powdered, etc.) or their assembly (prepared products). In Class: *Capsule 2- Microstructures*. *Demo: Denaturation of proteins ricotta cheese, cooking egg white foam; egg white foam starch: thickening of a sauce.*

**Lecture 3**. Food as materials. Miniaturizing food processing and cooking. The vitreous, rubbery and crystalline states. The glass transition temperature. Potato chips: from crispy to soggy. In Class: *Capsule 5- Transformations*. *Demo: sugar candy; sugar rubber; texturometer and crispness of Cheetos;*

**Lecture 4.** The map of preservation of food structures. Freezing and frozen foods. Heating in the kitchen and concepts of heat transfer. Effect of temperature on components of a food. Principles of lyophilization (freeze-drying). *Demo: freezing with liquid nitrogen (yoghurt ice cream), orange sachets, freeze-dried products.*

**Lecture 5.** Dispersed food systems. Gels: raw materials, formation mechanisms, types of gels, structures and properties. Culinary spheres. Emulsions: how to make and stabilize them. Mayonnaise, meat emulsions and dressings. Food foams. Methods for making foams and stabilizing them. Why does beer foam collapse? *Demo: Artificial egg yolks (reverse spherification); Meringues and vegan mayonnaise (soy milk).*

**Lecture 6**. Molecules that move; Concepts of molecular diffusion and convection. Release of aromas. Note-by-note cooking. Modeling the extraction from a tea bag in water. Drying and impregnation. Measurement of physical properties in the laboratory. In class: *Capsule 3- Instruments*. *Demo: Apple impregnation with wine, osmotic drying of yolks, use of manual colorimeter, measuring pH.*

**Lecture 7**. Development of textures. How does a food extruder work? Extrusion of proteins and starches: snacks and textured protein. Mechanisms of frying and the secrets of the wok. Absorption of oil and changes in fried products. *Demo: Frying of Puri sopaipillas; demo extruded products and visit extrusion lab.*

**Lecture 8**. Structure of milk and milk nanotechnology. Famous dairy products and the engineering of an ice cream. Wheat proteins and their visco-elasticity. Formation of bread structure in the oven. Manufacture of pastes, structure and their cooking. Concept of pasta *al dente* and glycemic index. *Demo: butter production, viscoelasticity of wheat gluten, pasta cooking (al dente).*

**Lecture 9**. Chemical and structural changes in meat and eggs during cooking. Barbecue in a calorimetry (making a good steak). Cooking *sous-vide*. The senescence of some food structures. Chocolate and its blooming. *Demo: cooking meat in a Roner and Maillard reaction (perfect meat), tempering of bloomed chocolate.*

**Lecture 10**. Theories of the expansion of structures. The ephemeral life of a soufflé. Why does popcorn inflate? Bases for the design of tasty and healthy structures. *In class: video popping of corn.* *Demo: Experiment with rice, balloons and soufflé.*

**Lecture 11.** About gastronomy, restaurants and chefs. Famous chefs and desserts. *Demo: Video winner: expansion of a soufflé*. In class; *Capsule 6- The work of a chef.*

Presentation of experimental cuisine and apparatus. Class by Maike Siegel.

**Lecture 12.** The creative process of chefs. Conversation with a famous chef.

**Lecture 13**. Savoring molecules: smell, taste and beyond. Sensory evaluation methodologies. Conversation with an expert in sensory panels. *Demo: Product evaluation.*

**Lecture 14**. The digestive system communicates with the brain. Digestion engineering. Why do not we absorb 100% of the nutrients? Bioavailability of nutrients and structure. Artificial digestive systems. Conversation with an expert in neurobiology.

**Topic 15**. What should we eat? Healthy diets (not healthy foods) and eating habits. Challenges of modern alimentation. *Homo gastronomicus* and gastronators. Conversation with a nutrition expert.

1. METHODOLOGY

**Students must read the assigned texts before the class**. Lectures will stress important aspects of the material read, present examples and promote questions and discussion. Presentations through slides, videos and conversation with guest speakers to further explain topics in the readings. Demonstrations of some culinary techniques **(bring your own spoon!)** and use of laboratory equipment with active participation of students. Final project that relates science/engineering to a food.

1. EVALUATION

**Quizzes.** **AT THE BEGINNING OF EACH CLASS,** a 10-15 minute quiz will be carried out on the reading asignment of the subjects that will be covered on that day (total 12 quizzes, worst 2 grades are eliminated). **A minimum attendance of 12 complete classes and a 4.0 average in the controls** (absences equal to grade 1) is required for the approval of the course. Attendance list will be passed. **Quizzes are in English** (multiple choices).

**Term project**. It will consist of a critical discussion about a product to be carried out by groups of 3 students expressed in a video of maximum 3 minutes that illustrates the most important points. In addition to the video, students will present a summary in English of their work (1 page, single spacing, font size 11). This report should use concepts such as microstructure, state diagram, mass heating / transport mechanisms, physical properties, etc., describe the materials and processes (where applicable)

There is no final exam. The final grade will be calculated according to:

• **Quizzes**: 70%

• **Term project** (and participation in specific tasks): 30%

1. BIBLIOGRAPHY

Text:

Aguilera, J.M. 2017. *Lecture Notes on Gastronomic Engineering (version 2017). Internal document.*

Basic bibliography:

Aguilera, J.M. 2013. *Edible Structures: the basic science of what we eat.* CRC Press, Boca Raton.

McGee, H. 2008. *La Cocina y los Alimentos*. Debate, Barcelona.

Anonymous. 1998. *Larousse Gastronomique*. Hamlin, Londres.

Additional bibliography:

Aguilera, J.M. 2009. *Ingeniería Gastronómica*. Ediciones UC, Santiago.

Barham, P. 2003. *La Cocina y la Ciencia*. Editorial Acribia, Zaragoza.

Coenders, A. 2007. *Química Culinaria*. Editorial Acribia, Zaragoza.

Damodaran, K., K.L. Parkin, O.R. Fennema,. 2007. *Food Chemistry 4th ed*. CRC Press, Boca Raton.

Lavalle, C. 2014. *Science Culinaire: matiere, procedes, degustation*. Belin, Paris.

This, H. 2008. *Molecular Gastronomy.* Columbia University Press, NY.

Vega, C., Ubbing J., van der Linden, E. 2012. *The Kitchen as Laboratory*. Columbia Univ. Press, NY.

Walstra, P. 2003. *Physical Chemistry of Foods*. Marcel Dekker, NY.

1. LECTURE SCHEDULE

**Lecture Schedule 2nd semester 2017**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lecture** | **Date** | **Subject** | **Reading**  **(Sections)** | **Quiz** |
| **1** | **August 3** | Molecules in our bodies and foods  The size of things we eat  A good look at food | **/** | **/** |
| **2** | **10** | Edible structures from nature  Processing of edible structures  **Handout of proposals of Term Project Ideas** | **1 - 4** | **1** |
| **3** | **17** | Cooking under the microscope  Food as engineering materials  From crispy to soggy | **5 - 8** | **2** |
| **4** | **24** | Preserving food structures  Heating: energizing molecules  **Term project. Presentation of a short review of literature and internet.** | **9, 10** | **3** |
| **5** | **31 (ALG)** | Gels: chewy water  Emulsions: mixing the enemies  Foams: structures out of thin air | **13-15** | **4** |
| **6** | **September 7** | Diffusion: molecules on the move  Measuring properties in the lab  **Term Project tutorials** | **11, 12** | **5** |
| **7** | **14** | Extrusion: continuous cooking and shaping  Frying: cooking in a very hot liquid  **Presentation project advance (grade)** | **16, 17** | **6** |
| **8** | **21** | Milk and dairy nanotechnology  Our daily bread  Pasta al dente | **18-20** | **7** |
| **9** | **28** | Meat: barbecue at the lab  The aging of foods  Chocolate also blooms | **21-23** | **8** |
| **10** | **October 5** | Soufflé: an ephemeral structure  Why does popcorn pop?  Designing food structures  **Presentation of trailer of video** | **26, 27, 29** | **9** |
| **11** | **12** | An introduction to gastronomy  Desserts | **24, 25, 28** | **10** |
| **12** | **19** | Chef’s choices and creation. Talking to a chef.  **Tutorial projects** | **/** | **/** |
| **13** | **26** | Tasting and smelling molecules  Testing foods by pros  Talking with an expert in sensory evaluation | **30-32** | **11** |
| **14** | **November 2** | Digestion: food processing inside our bodies  Towards healthy habits  Talking with an expert nutritionist | **33, 34** | **12** |
| **15** | **9** | The gut talks to the brain  Talking with a neurobiologist | **/** | **/** |
|  | **16** | **PRESENTATIONS** |  |  |

1. TERM PROJECT

The objective of the Term Project is to have a group of students gain hands-on experience by working in a problem of culinary or food sciences importance, plan and carry out a working plan, observe where the science and engineering is, and present **major findings as a 3-min video**.

1. Softening of vegetables for elderly with mastication problems – Alicia/Maike
2. Savory microgels to condiment foods – Alicia ([alleon@uc.cl](mailto:alleon@uc.cl))
3. Home-made vinegar from waste – Maike (maikesiegel@gmail.com)
4. Broth-base from anchovy wastes - Maike
5. Seaweed confectionery – Maike/Sole
6. Anchovy blocks to make flakes (*katsuobushi*) – Samuel BCC/Maike
7. The engineering of washing dishes - JMA
8. Fat-free whey protein Panacotta – Anaïs ([alavoisier@ing.puc.cl](mailto:alavoisier@ing.puc.cl))
9. High-protein, no sugar confectionery - Anaïs
10. Fullproof Hollandaise sauce – Mariel (mifarfan@uc.cl)
11. Ultra-light manjar - Mariel
12. Principles of a machine to gut anchovetas - JMA
13. Ground algae vs. ground meat hamburgers –Sole (cabrera.sole@gmail.com)
14. Concentrated extracts from algae –Sole
15. Changes in color and texture cochayuyo and pH - Sole

Work should be carried out **in groups of 3-4 members with different backgrounds in engineering.**  Selection for term project should be handed in on August 10 **in a 1-page document** containing title, background, objective, plan of work and expected results. Topics will be assigned on a first come, first served basis by registering in [alavoisier@ing.puc.cl](mailto:alavoisier@ing.puc.cl). Original proposals are not accepted. **Advance on term project**: 1-page document showing only results to that date.

**NOTES**

1. Most of the work should be made at home. In case needed, labs and the experimental kitchen will be available on Mondays 14:00-18:00 previous registration.
2. Extensive use of digital photography.
3. Results presented as a short video (max. 3 min) and 1-page report with references.

**CRITERIA FOR GRADING THE TERM PROJECT**

1. Completeness and pertinence of the **literature review** (including internet)
2. Challenge presented in the hypothesis and objectives
3. Where corresponds, the physical model and variables
4. The “elegance” of the experiment to verify the hypothesis (materials and methods)
5. Excellence of **scientific and engineering** explanations
6. **Autonomy** and creativity of work performed
7. Appropriateness of facts presented in the discussion
8. Clarity and robustness of conclusions
9. Quality of the presentation in the **video** which may be in Spanish.

**Grade calculation.** Course ranking: 35%; Professor’s grading: 65% (15% advance on term project, 50% final report).