Food Physical Systems (11:400:419): Fall 2016

Instructor

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Text

There is no text for the course. Content will be covered through materials available (primarily) through the course Canvas site. I recommend you also refer to *On Food and Cooking* (2004) by Harold McGee, a highly readable survey of the science of a wide variety of foods, enlivened with history and culture. This is a book that should be on every food scientist's bookshelf. It is available at a discount from Amazon.

Intent of the Course

This is a course in the physical chemistry of foods. It is an introduction to those physical and chemical principles that describe how food composition, molecular properties, and interactions among molecules give rise to food properties. We will investigate how the chemical composition and molecular structure of specific foods and food ingredients determines their macroscopic physical properties, interactions with other foods, chemical reactivity, and response to specific processing operations such as heating, freezing, drying, mixing and pouring, and pressurizing.

The course thus serves as a conceptual bridge between food chemistry and food engineering.

We will emphasize a conceptual over a quantitative understanding of how chemical structure results in macroscopic physical properties, how specific physical chemical mechanisms underlie a food's response to specific processing operations, and how physical chemical concepts can be used to understand, predict, and thus control food quality and stability. Our efforts much of the time will be devoted to describing the molecular mechanisms that underlie the macroscopic behavior of foods and in explaining these mechanisms in terms of the physical and chemical properties of specific molecules. Since a full coverage of food physical chemistry is impossible in one semester, or ever in an introductory course such as this, only selected topics directly relevant to foods will be covered. However, as you might expect, these topics are all fairly complicated as they describe complex interactions in complex liquids and solids ranging from vitamin water to ice cream or lemon meringue pie.

Course Learning Outcomes

After successfully completing this course, students will be able to:

>Use the thermodynamic principles of enthalpy, entropy, and free energy to describe and explain physical and chemical changes in foods.

>Describe the physical properties of water and water solutions, including acid/base behavior, colligative properties, and water activity, and their influence on the properties of foods.

>Explain how the concept of surface tension (surface free energy) is used to understand the behavior of food molecules at air/water and oil/water interfaces and be able to describe the consequences of this behavior for the structure and stability of food emulsions and foams.

>Describe the structure and physical properties of food polymers (hydrocolloids) and explain how the functional properties of foods, in particular their viscosity and texture, reflect the structure, dynamics and interactions of these polymers.

>Describe how the colloidal composition and structure of specific foods influences their behavior and properties and in particular how the colloidal structure of milk influences its transformation into butter, yoghurt and cheese.

>Describe the mechanism of crystal formation, outline the properties and phase behavior of crystalline solids (especially fats), and explain how crystals and crystallization influence food properties and stability.

>Describe the mechanism of formation of amorphous (non-crystalline) solids, outline the properties and state behavior of amorphous solids (especially sugars), and explain how amorphous solids influence food properties and stability.

Course Policies and Procedures

Quizzes: Many classes will begin with a short (5 minute) quiz, usually 1-2 questions, based on previous class material or on a specific assignment for that day. The quiz provides immediate feedback on comprehension, indicates which concepts and topics are considered important, and ensures that everyone comes to class on time.

Assignments: These are mostly problem sets. The assignments are indicated in the modules. Due dates are listed in the FPS Class Topics handout.

Term Project: You will choose a specific food or food ingredient and do a detailed physical chemical analysis of it. This analysis will relate the molecular composition and structure (at levels from nanometers to centimeters) to the specific macroscopic properties of the food. The analysis should include how the molecular properties affect

manufacture, storage and shelf-life, typical use, sensory properties, etc. You will summarize your analysis in a well organized, well written and appropriately referenced term paper and present the results of your analysis in a poster session (date to be determined).

Exams: There will be one midterm and a final exam.

Grading: The final grade will be based on the following weighting of the course content.
5% Quizzes
20% Assignments
25% Term project
25% Midterm exam
25% Final exam

Letter grades will be assigned (approximately) as follows:
A 90-100
B+ 86-89
B 80-85
C+ 76-79
C 70-75
D 60-69

Class Format

Readings: Much of the information and content in this course will be provided through readings from the material provided on line (through the Canvas site). It is essential that you peruse the assigned readings **before class** so that we can discuss and apply the concepts to specific foods **in class**.

Class activities: Small group and class discussions, problem solving, case studies, and short lectures will provide the main mechanisms for learning in this class. Class activities will assume that you have read an assigned reading. If you fail to do so, therefore, you may be bored, confused, and frustrated in class; as a consequence, you almost certainly will not do as well in the course as you would like.

Academic Integrity
All students are expected and required to be familiar with the rules and regulations of Rutgers University dealing with academic integrity and issues of cheating and/or plagiarism of intellectual material from either printed or electronic sources. Any suspected instance of a violation of these rules will be reported to the appropriate university officials and will be handled strictly in accordance with established university policies. All written assignments will be analyzed using Turnitin software to detect potential plagiarism.

Such a violation can result in consequences ranging from receiving zero credit for an assignment or test to receiving a failing grade in this class to permanent expulsion from Rutgers University with an indication of this action placed on your permanent University record. Further information is available at the Office of Student Judicial affairs web site: http://academicintegrity.rutgers.edu.

Term Project

This capstone project will allow you to practice what you have learned in the course by performing a detailed physical chemical analysis of a specific food or food ingredient. Past examples have included peanut butter, whipped cream, tofu, Twinkie, chicken eggs, etc. You will choose a topic based on consultation with the instructor.

Your description/analysis should cover (where appropriate):
Method of manufacture (as relates to structure and properties)
Composition (main functional ingredients)
Structures found in the food (from macro to nano-scale levels):How generated and how maintained
Physical properties of the food important for:
Manufacturing (viscosity, etc.)
Storage and shelf-life (chemical reactions and physical processes)
Sensory appeal
"Making it the food it is" (specific properties)
Molecular basis for structures and physical properties
Roles of specific food components in generating/maintaining structure and physical properties
Interactions among components and the role these interactions play in structure/properties
Specific physical chemical principles at work in the food

Possible paper format:
Introduction
Manufacture
Composition
Structures
Physical properties and molecular basis including connection to physical chemical principles
Conclusion: summary of the essential structure/properties and relation to molecular composition
Bibliography: must cite books and journal articles as well as web sites

Timeline:
Sept. 28 Summary (< 1 page) outline/description of the topic chosen for term project
Oct. 28 Detailed (~2 page) outline of paper describing the main topics that will be covered with a list of 7-10 references (journal articles, books, web sites, etc.)
Dec. 7 Poster summarizing the main points in your paper

Dec. 9 Final term paper due

STUDENT WELLNESS SERVICES

Just In Case Web App
http://codu.co/cee05e Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS)
(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ www.rhscaps.rutgers.edu/
CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)
(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / www.vpva.rutgers.edu/
The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932- 1181.

Disability Services
(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / https://ods.rutgers.edu/
Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Scarlet Listeners
(732) 247-5555 / http://www.scarletlisteners.com/
Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.