

**RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY  
SCHOOL OF ENVIRONMENTAL and BIOLOGICAL SCIENCES**

**Department of Food Science**

<b>COURSE TITLE</b>	<b>Food Physical Systems</b>
<b>COURSE NUMBER</b>	11:400:419
<b>CREDITS</b>	3
<b>SEMESTER(S) OFFERED</b>	Fall
<b>CLASS DETAILS</b>	
Days/ Time(s)	M/W 2:15-3:35 p.m.
Location	FS101
<b>PREREQUISITE(S)</b>	Physics I ( <i>01:750: 193 or 201 or 203 and 205</i> ) & Physics II ( <i>01:750:194 or 202 or 204 &amp; 206</i> ) & Calculus I ( <i>01:640:135 or151</i> ) & Calculus II ( <i>01:640:136 or 138 or 152</i> ) & Biochemistry ( <i>11:115:301 or 403</i> )
<b>INSTRUCTOR INFORMATION</b>	
Name	Shiu-Ying Ho, PhD
Phone	N/A
Email	<a href="mailto:syho@sebs.rutgers.edu">syho@sebs.rutgers.edu</a>
Office Hours [Day(s) & Time(s)]	By appointment
Office Address	Rutgers Department of Food Science 65 Dudley Rd, New Brunswick, NJ 08901
<b>COURSE DESCRIPTION</b>	
Food Physical Systems (11:400:419) is a 3-credit course and is an introductory course to 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 structure (at levels from nm to cm), 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 (squeezing).

### **COURSE OBJECTIVES**

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

1. Use the thermodynamic principles of enthalpy, entropy, and free energy to describe and explain physical and chemical changes in foods.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.

### **PROGRAM LEARNING GOAL (S) SATISFIED BY THIS COURSE:**

**LG #2: Graduates will demonstrate and apply knowledge of the core competencies in Food Chemistry and analysis.**

### **Student Learning Goals and Outcome**

**2.1:** Understand the chemistry involved in the properties and reactions of various foods and its components.

**2.2:** Understand and effectively applies the principles behind analytical techniques associated with food.

**2.3:** Understand and effectively applies food chemistry and analysis methods.

### **FURTHER INFORMATION ON THE COURSE:**

- This course serves as a conceptual and explanatory 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 molecular interactions give rise to specific food structures, how specific physical and chemical mechanisms underlie a food's response to specific processing operations, and how physical and chemical concepts can be used to understand, predict, and thus control food quality and stability.
- We will spend much our time to describe 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 even 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 multiple and varied interactions in complex liquids and solids ranging from vitamin water to ice cream or lemon meringue pie.

### **Course Policies and Procedures**

*Assignments:* Required assignments will be due throughout the semester. These assignments involve learning how to edit and add content--text, pictures/videos, equations, references--to articles on food, food ingredients, food processes or concepts important for understanding the physical properties of foods.

*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, molecular properties, and structure (at levels from nanometers to centimeters) to the specific macroscopic properties of the food. It will thus be an exercise in applying the physical chemical concepts from our class to a specific food. More information about this requirement will be provided at the appropriate time. However, you should begin choosing a topic, that is, choosing a food that you want to investigate, as soon as possible.

*Exams:* Three take-home exams will be given.

*Grading:* The final grade will be based on the following weighting of the course content.

25% Assignments

30% Term paper

15% Exam 1

15% Exam 2

15% Exam 3

Final 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

F < 60

<b>COURSE SCHEDULE/ TOPICS OUTLINE</b>		
<b>Day/Date</b>	<b>Topic</b>	<b>Exam/ Assignment</b>
W 9/5	Introductions; Systems; Term Paper rubric	
M 9/10	Thermodynamics First Law: Heat & Work; Enthalpy	
W 9/12	Thermodynamics Molecular Interactions & Enthalpy; Boltzmann Distribution	
M 9/17	Thermodynamics Second Law: Entropy; Spontaneity	
W 9/19	Thermodynamics Free Energy; Equilibrium	“Choose your topic/Find your sources.” Due 9/26
M 9/24	Thermodynamics Phase Changes & Free Energy	
W 9/26	Aqueous Solutions  Food Acids; Charge & pH	
M 10/1	Aqueous Solutions  Carbonation: Gas Solubility; Supersaturation	
W 10/3	Aqueous Solutions  Chemical Potential; Water Activity; Activity Coefficients	
M 10/8	Exam 1	Write a detailed outline of your term paper. Submit to instructor for feedback by 10/22.

W 10/10	Aqueous Solutions Colligative Properties	
M 10/15	Food Surfaces Interfaces; Surface Energy	
W 10/17	Food Surfaces Amphiphiles; Surface Adsorption	
M 10/22	Food Surfaces Emulsions	“Add description of molecular composition to an article.” Due 11/5
W 10/24	Food Surfaces Foams	
M 10/29	Hydrocolloids Hydrocolloid in Foods	
W 10/31	Hydrocolloids Hydrocolloids: Solution Viscosity	
M 11/5	Hydrocolloids Hydrocolloids: Gelation	“Add description of food structure to an article.” Due 11/19
W 11/7	Hydrocolloids Hydrocolloids In Solution: Polymer Conformations	
M 11/12	Exam 2	
W 11/14	Food Colloids Milk & Milk Products	
M 11/19	Food Colloids Colloidal Interaction	
W 11/21	No Class: Thanksgiving Break (Friday Schedule)	
M 11/26	Food Solids Crystallization	“Add math equation to an article.” Due 12/3
W 11/28	Food Solids	

	Fat Crystals	
M 12/3	Food Solids Amorphous Solid Foods I	
W 12/5	Food Solids Amorphous Solid Food II	
M 12/10	Exam 3	
W 12/14	Term Paper due by 11:50 pm	

## 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/](http://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/](http://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.