FNH 301 Food Chemistry Syllabus

Course Details

Course	FNH 301 Food Chemistry I [3-0-1] (hours/week of [lecture-lab-tutorial])
Prerequisites	One of CHEM 201, 205 and one of CHEM 203, 233
Term/year	Winter term 1 (September - December 2020)
Class day/time	M.W.F. 10:00-11:00 (lecture)
Class location	Online through Zoom
	Introduction & Water:
	Other chapters:

Instructor	David Kitts; Anika Singh; Rickey Yada (guest instructor)
Email	david.kitts@ubc.ca; anika.singh@ubc.ca; rickey.yada@ubc.ca
Office	FNH Building, room 243; 604-822-5560
Office hours	TBA
TAs	Amelie Zhang and Ted Yu
TA contact	amelie.huiying.zhang@ubc.ca; tedyu@mail.ubc.ca
Syllabus version	September 2020

Instructor's Biographical Statement

Dr. David D. Kitts	MSc. - UBC (76'), Ph.D - UBC (81'); PDF. - UCD (83')
Rank	Professor
Program	Food Science; Food, Nutrition and Health
Specialty Disciplines	Food Chemistry; Toxicology
Current courses taught at UBC	FNH 301 Food Chemistry
	FOOD 525 Food Toxicology and Risk Assessment
Research Interests	Bioactives; Food Lipids and Antioxidants
	Food Processing - Nutritional/Toxicological Quality & Safety
Administration	Associate Dean Research, Faculty of Land and Food Systems
Advisory Boards	Canadian Sugar Council (CSI)
	International Life Sciences (ILSI) - North America

Course Objectives

FNH 301 will develop students' theoretical knowledge of food chemistry and critical thinking skills for employment in the food industry and to communicate food chemistry applications to a variety of audiences. Major topic areas include chemical reactions in food; constituents of food; and chemical properties of water, carbohydrates, proteins, lipids, minerals and vitamins.

Learning Outcomes

By the end of FNH 301, students will be able to:

1. Discuss the complex nature of the food matrix
2. Describe the chemical composition and properties of major constituents in foods
3. Explain the forces that maintain the structure of a heterogeneous mixture of food components dispersed in a common matrix
4. Explain the biochemical transformations common to post-harvest storage, biodegradation and processing of foods
5. Evaluate molecular, structural and physical properties of food that influence food's functional, organoleptic, nutritional and safety properties
6. Predict interfacial changes specific to different food systems
7. Apply food chemistry concepts to food processing and food safety situations

Course Format

There are three class lectures in traditional format given per week by the Instructor that cover seven major topics (see below), considered basic first principles for understanding the chemical and enzymatic reactions that occur in foods.

Lectures are supplemented with six topic-specific tutorials that reinforce the chemical methodology used to distinguish the different food components and associated food chemical reactions. These exercises are student-centered with TA support.

Students will work in groups of four or five on a group project with oral presentation and written report. Groups will apply learning about a specific food chemistry reaction to traditional and processed food products.

Due to COVID-19, this year the course will have synchronous online lectures on Zoom and asynchronous online tutorials on Canvas. The office hours will be synchronous on Zoom. Group projects will still include student presentations and a written summary report.

Traditional lectures - face-to-face lectures (this year: Zoom lectures) with online notes
Tutorials - TA instruction on simulated laboratory exercises; these are student-centred and encourage student discussion
Oral presentation and written reports - students research topics in groups, produce an oral presentation and written report

Learning Activities

Student participation is encouraged in class by working in small groups to assimilate knowledge on specific (contemporary/novel) topics important for a food chemist. Question and answer periods are provided after each section of the course content. Specific readings are introduced for students to expand their knowledge on related food chemistry topics (see references below).

Course Readings

Reference resource textbook

Food Chemistry, 3rd, 4th Editions. O.R. Fennema

Class lecture notes on Canvas

Supplemental reading

Kitts, D.D. (2019). Dietary Lipids and Physiological Function. In F. Shahidi (Ed.), *Bailey's Industrial Oil and Fat Products* (7th ed.) Manuscript ID biof.20160105.

Journals helpful for group projects

Food Technology (IFT)
Journal of Agricultural Food Chemistry (ACS)
Journals of Food Science and Food Research International (IFT; CIFST)
Journal of Food Chemistry (Brit. FS)

Course Schedule

Note: page numbers below refer to Fennama's Food Chemistry (3rd edition)

Introduction to Food Chemistry: 1 lecture
An introductory lecture on the role of food and food technologies in contemporary lifestyle, with examples of food chemistry advances and the impact on today's food supply.

1. Chemistry of water in food.

Topics Include: Reference Reading in Food Chemistry, Chapter 2. pp #

- Physical-Chemical properties of water p. 19-23
- Physical properties of ice p. 24-29
- Water-solute interactions p. 30-47
- Water activity concepts p. 42-55

These lectures provide information on the physical properties of water and ice; water-solute interactions; water activity and binding; roles of water in chemical reaction rates and microbiological growth. Water and the basis of some food technologies (e.g. freezing, freeze drying)

- **Tutorial #1: Water in Food Systems.**

2 & 3. Chemistry of carbohydrates in food.

Topics Include: Reference Reading in Food Chemistry, Chapter 4. pp #

• Monosaccharide chemistry	p. 157-161
• Oxidation, reduction reactions	p. 167-169
• Non-enzymatic browning	p. 171-174
• Sweetness chemistry/sweeteners	p. 727-8; 794-6
• Caramelization (see reader)	p. 716
• Oligosaccharide chemistry	p. 174-177
• Polysaccharide chemistry	p. 178-179
• Starch, cellulose chemistry	p. 191; 205
• Starch granule morphology	p. 193
• Gelatinization and pasting	p. 195-197
• Retrogradation and Staling	p. 198
• Hydrolysis reactions	p. 199
• Modified starches	p. 201-205
• Pectins	p. 216-17; 494-96

Lectures emphasize the identification and function of carbohydrate (e.g. mono, oligo - & polysaccharides); Chemical reactions (Maillard reaction, caramalization). Chemistry of sweetness (structure/activity relationships) of nutritive and non-nutritive sweeteners in foods. Lectures on chemistry and structure of polysaccharides to include starch, celluloses, pectins. Starch chemistry to include component sugars, granule structure, gelatinization, retrogradation and staling. Functional properties of starch hydrolysis products, modified starches.

- **Tutorial #2: Carbohydrates 1 (Monosaccharides and Browning Reactions).**
- **Tutorial #3: Carbohydrates 2 (Polysaccharides).**

4. Chemistry of amino acids and proteins in foods.

Topics Include: Reference Reading in Food Chemistry, Chapter 6. pp #

• Amino acid structure/classification	p. 232-326
• Nutritional/safety factors	p. 396-399
• Carbonyl-amine reactions	p. 412-413
• Protein-protein interactions	p. 346-352
• Denaturation	p. 353-54; 362-63
• Functional properties	p. 365-69; 370-73
• Milk protein structure-function	p. 846; 855-58; 861

Lectures emphasize the structure and classification of amino acids in food proteins, including:

- Physio-chemical properties of amino acids - e.g. solubility
- Chemical reaction of amino acids - e.g. esterification & acylation
- Reaction of amino acids in non-enzymatic browning
- Amino acid sources and reaction in vasoactive amine production
- Classification of food proteins; protein functionality - structure/function relationships with emulsification, foaming, gelation and binding

- Chemical changes in proteins with denaturation
- Chemistry of casein proteins will be used as an example of all principles

➢ **Tutorial #4: Amino Acids and Proteins.**

5. Chemistry of fats and oils in foods.

Topics Include: Reference Reading in Food Chemistry, Chapter 5. pp #

• Classification/Metabolic pathways	p. 226-31; 232-34
• Polymorphism	p. 244-248
• Fatty acid oxidation (auto-oxidation)	p. 254-68; 272-76
• Sterols & sterol oxidation	p. 266-268
• Lipid oxidation measurements	p. 276-279
• Thermal degradation of fat	p. 288-290
• Chemistry of fat/oil processing	p. 299
• Hydrogenation	p. 300-04; 311
• Interesterification	p. 304-306

Lectures emphasize the chemical classification of fats and oils in animal and plant food systems. The following chemical reactions of fats and oils are discussed - positional distribution of fatty acids, lipid oxidation reactions, interesterification, hydrogenation and polymorphic behaviour of commercial fats.

➢ **Tutorial #5: Lipids.**

6. Food Additives.

Topics include: Reference Reading in Food Chemistry, Chapter 12. pp #

• Acid-base buffering	p. 619-20; 769-70; 775-77; 78
• Sequestering agents/phosphates	p. 623-25; 778-80
• Antioxidants	p. 780-782
• Emulsifiers	p. 133-140

Lectures emphasize common food additives and their roles in stabilizing food systems.

➢ **Tutorial #6: Food Additives.**

Course Assessment

The course is graded on a numeric percentage as follows:

Midterm exam	25%
Tutorial participation	5%
Tutorial exam	15%
Group project	15% (*Multiplier based on peer evaluation will be applied)
Final exam	40%

Tutorial participation will be given at the end of tutorial 2-6, in the form of short answer, for one critical thinking question, to be given in class. This will be worth 1% each. You will be given one week to complete the assignment on canvas, and credit will be given as long as critical thinking is shown for the answer given. After one week, the answer will be posted onto canvas.

The midterm and tutorial exams will be given as an oral exam of multiple-choice questions examined by Dr.Kitts, Ted and Amelie. Students will be assigned into groups of 4-5, taking a real-time exam on Zoom. Each student in the group will be assigned one set of questions, covering each chapter that has been covered in class/tutorial. The student will be asked to answer the question, and then other students in the group will also provide their answer. After all group members have given their answer, the student will be asked to explain their answer. A correct choice is worth half of the marks, and a correct explanation is worth the other half. Students may change their mind after listening to others' answer, in this case, a correct answer with a correct explanation would be worth half of the mark. The process will be carried out for each student in the group, and each student will be asked to give and explain the answer for their own set of question, but only provide an answer for other students' question set. The overall grade for the exam will be the collective marks from students' answers and explanations to their own questions (50%), plus their answers to group members' question sets (50%). **Figure 1** on next page diagrammatically illustrates how the oral exam proceeds.

The group project assesses students' ability to critically read and interpret an academic publication in the food science discipline. Students will be assigned into groups of 4-5 with a paper and will be asked to show their understanding on the material by making a video presentation and writing a term paper. Rubric for the project will be provided when the topics are assigned to each group. *Peer evaluation will be performed to assess workload distribution in a group, and the results will be used as a multiplier for the project grade that an individual receive Details will be announced later in the term.

Details for the final exam will be announced later in class.

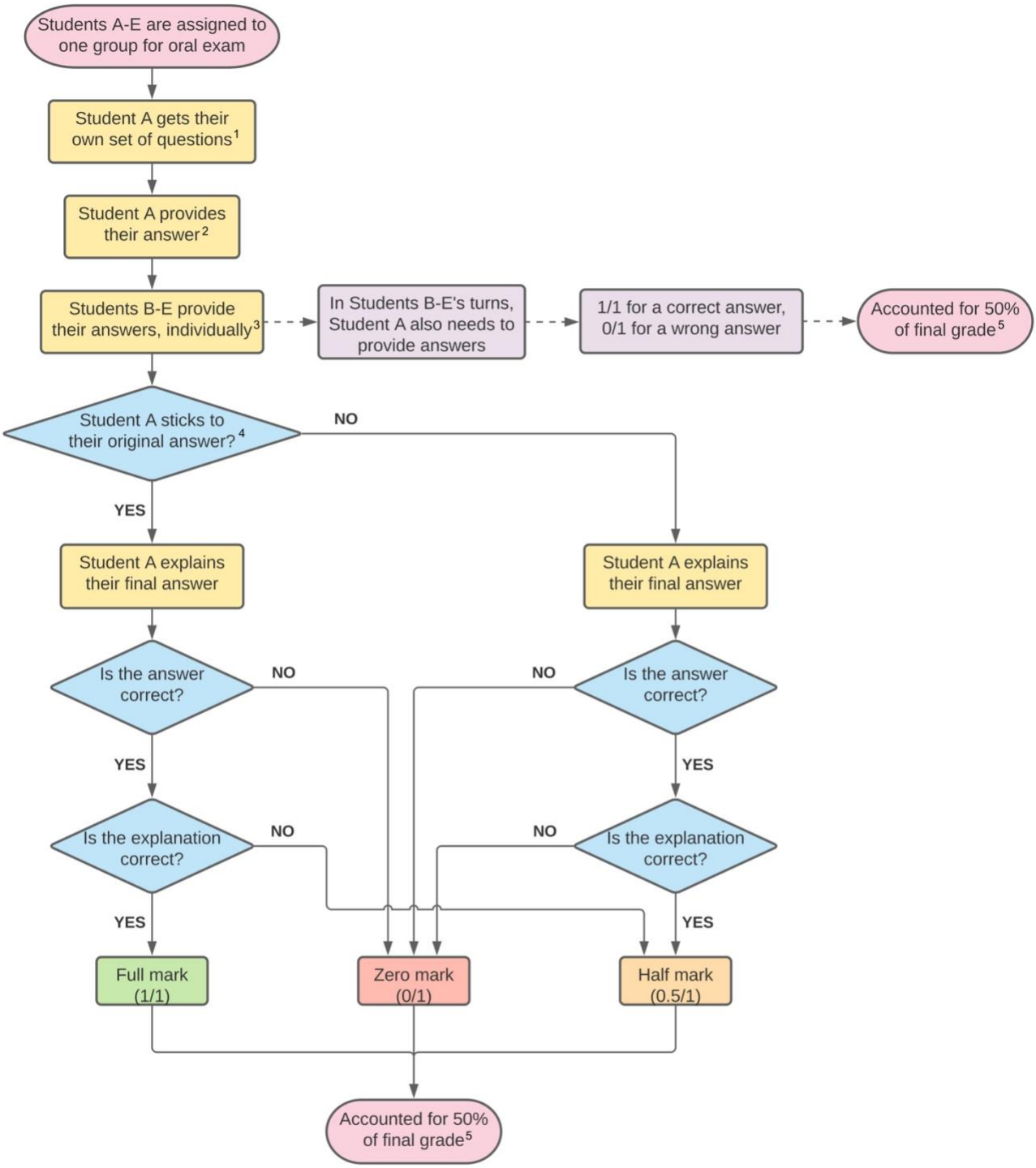

Figure 1. A flowchart illustrating the procedure of FNH 301 oral exam.

[1] Each student in a group will be assigned a different set of multiple-choice questions, which include 1-2 questions per chapter that has been covered.
[2] One question will be asked in one turn.
[3] The order of group members answering the question will be randomized each turn to ensure fairness.
[4] Students are allowed to change their mind and select another answer after listening to the answers from group members.
[5] The final marks of a student is calculated as the sum of the marks they gets from answering and explaining their own set of questions (50%) plus answering their group members' sets of questions (50%).

Learning Analytics

Learning analytics include the collection and analysis of data about learners to improve teaching and learning. This course will be using Canvas learning technologies and its integrated tools.

Academic integrity

FNH 301 brings forth important examples of ethics relevant to food industry activities. Student conduct in the academic enterprise that focuses on class activities is founded on student honesty, civility, and integrity for the establishment of individual reputation. All UBC students are expected to behave as honest and responsible members of an academic community. At the most basic level, this means submitting only original work done by the student, and acknowledging all sources of information, or ideas, attributed to others are required. There is zero tolerance for cheating, copying or misleading others about the student's original work. It is emphasized that this code of conduct at University is also the code of conduct that professionals in the food industry must follow.

The University of BC considers it to be the student's obligation to learn, understand and follow the standards for academic honesty and integrity. Students are made aware that standards at the University of British Columbia may be different from those in secondary schools or at other institutions.

Violations of academic integrity lead to the breakdown of the academic enterprise, and therefore serious consequences follow. Plagiarism or cheating may result in a mark of zero on an assignment, exam, or course. More serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Academic misconduct may result in a one-year suspension from the University and a notation of academic discipline on the student's record.

The UBC library has a useful Academic Integrity website that explains what plagiarism is and how to avoid it. If a student is in any doubt as to the standard of academic honesty in a particular course or assignment, then the student must consult with the instructor as soon as possible. A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar. All course work is required to be submitted to Turnitin.com for review.

University Policies

Policies and Resources to Support Student Success

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions.

Details of the policies and how to access support are available on **the UBC Senate website.**

Statement regarding online learning for international students during the COVID pandemic

During this pandemic, the shift to online learning has greatly altered teaching and studying at UBC, including changes to health and safety considerations. Keep in mind that some UBC courses might cover topics that are censored or considered illegal by non-Canadian governments. This may include, but is not limited to, human rights, representative government, defamation, obscenity, gender or sexuality, and historical or current geopolitical controversies. If you are a student living abroad, you will be subject to the laws of your local jurisdiction, and your local authorities might limit your access to course material or take punitive action against you. UBC is strongly committed to academic freedom, but has no control over foreign authorities (please visit http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,33,86,0 for an articulation of the values of the University conveyed in the Senate Statement on Academic Freedom). Thus, we recognize that students will have legitimate reason to exercise caution in studying certain subjects. If you have concerns regarding your personal situation, consider postponing taking a course with manifest risks, until you are back on campus or reach out to your academic advisor to find substitute courses. For further information and support, please visit: http://academic.ubc.ca/supportresources/freedom-expression.

Copyright

All materials of this course (course handouts, lecture slides, assessments, course readings, etc.) are the intellectual property of the Course Instructor or licensed to be used in this course by the copyright owner. Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline.

Students are allowed to record the classes if they first approach the instructor to explain the reasons for this activity.

Institute of Food Technologists (IFT)

UBC's Food Science Program is one of few in Canada that are approved by the Institute of Food Technologists (IFT), an internationally recognized leader in undergraduate education standards for degrees in Food Science. Programs with this approval badge are recognized as delivering a comprehensive Food Science education that covers 55 essential learning outcomes (ELOs) established by the IFT organization. For further information on IFT ELOs, click here. The highlighted ELOs below are covered in this course.

Institute of Food Technologists Essential Learning Objectives (IFT ELOs)

IFT ELOs that are highlighted in bold from the list below are covered in FNH 301. They are also summarized here as: **Food Chem.(FC) FC 1,2,3,4; Food safety (FS) FS 1,2,3; Food Engineering (FE) FE 6; Quality Assurance (QA) QA 3. Critical Thinking and Problem Solving (CTPS) CTPS 2,3; Food Science Communication (CM) CM 2,3; Professional Leadership (PL) PL 1,2,4**

Food chemsitry (FC)
FC.1. Discuss the major chemical reactions that limit shelf life of foods.
FC.2. Explain the chemistry underlying the properties and reactions of various food components.
FC.3. Apply food chemistry principles used to control reactions in foods.
FC.4. Review chemical techniques that explain basic and applied food chemistry.
FC.5. Demonstrate practical proficiency in a food analysis laboratory.
FC.6. Explain the principles behind analytical techniques associated with food.
FC.7. Evaluate the appropriate analytical technique when presented with a practical problem.
FC.8. Design an appropriate analytical approach to solve a practical problem.

Food microbiology (FM)
FM.1. Identify relevant beneficial, pathogenic, and spoilage microorganisms in foods and the conditions under which they grow.
FM.2. Describe the conditions under which relevant pathogens are destroyed or controlled in foods.
FM.3. Apply laboratory techniques to identify microorganisms in foods.
FM.4. Explain the principles involved in food preservation via fermentation processes.
FM.5. Discuss the role and significance of adaptation and environmental factors (e.g., water activity, pH, temperature) on growth response and inactivation of microorganisms in various environments.
FM.6. Choose relevant laboratory techniques to identify microorganisms in foods.

Food safety (FS)
FS.1. Identify potential hazards and food safety issues in specific foods.
FS.2. Describe routes of physical, chemical, and biological contamination of foods.
FS.3. Discuss methods for controlling physical, chemical and biological hazards.
FS.4. Evaluate the conditions, including sanitation practices, under which relevant pathogenic microorganisms are commonly controlled in foods.
FS.5. Select appropriate environmental sampling techniques.
FS.6. Design a food safety plan for the manufacture of a specific food.

Food engineering and processing (FE)
FE.1. Define principles of food engineering (mass and heat transfer, fluid flow, thermodynamics).
FE.2. Formulate mass and energy balances for a given food manufacturing process.
FE.3. Explain the source and variability of raw food materials and their impact on food processing operations.
FE.4. Design processing methods that make safe, high-quality foods.
FE.5. Use unit operations to produce a given food product in a laboratory or pilot plant.
FE.6. Explain the effects of preservation and processing methods on product quality.
FE.7. List properties and uses of various packaging materials and methods.
FE.8. Describe principles and practices of cleaning and sanitation in food processing facilities.
FE.9. Define principles and methods of water and waste management.

Sensory science (SS)
SS.1. Discuss the physiological and psychological basis for sensory evaluation.
SS.2. Apply experimental designs and statistical methods to sensory studies.
SS.3. Select sensory methodologies to solve specific problems in food.

Quality assurance (QA)
QA.1. Define food quality and food safety terms.
QA.2. Apply principles of quality assurance and control.
QA.3. Develop standards and specifications for a given food product.
QA.4. Evaluate food quality assessment systems (e.g. statistical process control).

Food laws and regulations (FL)
FL.1. Recall government regulatory frameworks required for the manufacture and sale of food products.
FL.2. Describe the processes involved in formulating food policy.
FL.3. Locate sources of food laws and regulations.
FL.4. Examine issues related to food laws and regulations.

Data and Statistical Analysis (DS)
DS.1. Use statistical principles in food science applications.
DS.2. Employ appropriate data collection and analysis technologies.
DS.3. Construct visual representation of data.

Critical thinking and problem solving (CT)
CT.1. Locate evidence-based scientific information resources.
CT.2. Apply critical thinking skills to solve problems.
CT.3. Apply principles of food science in practical, real-world situations and problems.
CT.4. Select appropriate analytical techniques when presented with a practical problem.
CT.5. Evaluate scientific information.

Food Science Communication (CM)
CM.1. Write relevant technical documents.
CM.2. Create oral presentations.
CM.3. Assemble food science information for a variety of audiences.

Professionalism and leadership (PL)
PL.1. Demonstrate the ability to work independently and in teams.
PL.2. Discriminate tasks to achieve a given outcome.
PL.3. Describe social and cultural competence relative to diversity and inclusion.
PL.4. Discuss examples of ethical issues in food science