Food Analysis

Food 3002A, Winter 2024

Course Instructor: Dr. Yaxi Hu (yaxihu@cunet.carleton.ca), Assistant Professor, Food Science
Lab Coordinator: Winifred Akoetey (winifredakoetey@cmail.carleton.ca)

Lecture Sections: Monday & Wednesday, 1:05 pm – 2:25 pm (Southam Hall 303)
Lab Sections:

A1: Tuesday: 8:35 am – 11:25 am (Steacie Building 409)
A2: Thursday: 8:35 am – 11:25 am (Steacie Building 409)

Office Hours: Monday, 3:30-4:30 pm, Steacie Building Room 229
Notes: Feel free to send me an email for anything you want to tell and/or ask me and I will try my best to respond within 48 h. If you would like to talk to me in person outside the office hours, please email to make an appointment.

Course Description

The chemical composition of a food is of critical importance for the evaluation of the nutrition and health, the toxicology and safety, the quality and authenticity, as well as the stability to microbiological, chemical or physical changes. Analysis of food components and characteristics is necessary for managing the quality of food products, for providing consumers with health and nutrition information, and for ensuring the compliance with government regulations and policies regarding the nutrition labeling and food safety, quality and authenticity requirements. Selecting appropriate analytical techniques is the foundation to acquire reliable results, which depends on a good knowledge of the various techniques and the nature of products being analyzed.

The focus of this course is on introducing the principles and procedures of a variety of analytical techniques for the measurement of the composition and characteristics of food products. Topics to be covered include sample handling and preparation, reporting of data, analysis of major (*i.e.*, proximate analysis: moisture, ash, protein, lipid, and carbohydrate) and minor (*e.g.*, mineral, acids, vitamins and antioxidants) food components. The applications and principles of advanced analytical techniques including spectroscopy, titration, potentiometry, electrophoresis, chromatography, mass spectrometry and molecular techniques will be explored using examples of selected food chemical components (*e.g.*, vitamins, minerals, carbohydrates, proteins, lipids) and food integrity (*i.e.*, safety, quality and authenticity) cases.

Course Learning Outcomes (LOs)

Upon successful completion of this course (lecture and lab), you will be able to

Learning Outcomes	This includes the ability to:
LO1. Explain the importance of food integrity and food analysis	• Define food integrity, explain the relationship and differences of food integrity issues (*i.e.*, safety, quality and authenticity), and describe their impact to all stakeholders (*i.e.*, food industry, consumers and government) • Define food analysis and identify their application scenarios (*e.g.*, labeling, rapid screening)
LO2. Select appropriate analytical methods based on the purpose of analysis and properties of foods	• Describe the principles and procedures of analytical methods, including sample handling and preparation • Recognize and explain technical terminology and scientific units related to food analysis and labeling • Evaluate analytical methods for sensitivity, accuracy, reproducibility, time, complexity, and cost • Identify the purpose of food analysis (*e.g.*, proximate analysis vs characterization of a specific food component; and quality control vs rapid screening) and the impact of food matrix on the performance of food analytical methods • Rank and select the appropriate analytical method(s) for a specific application based on the advantages and disadvantages of different analytical methods
LO3. Design and perform experiments for specific applications of food analysis	• Identify reliable sources and key information related to design / perform a food analytical experiment • Critique experimental design in scientific publication for food analysis • Perform mathematical calculations involved in the preparation of samples and reagents for food analysis • Perform experiments of food analysis following established protocols • Analyze and interpret the results acquired using different methods
LO4. Apply principles of green analytical chemistry to food analysis	• Explain the 12 principles of green analytical chemistry, their importance and their impact on the performance of analytical methods • Assess the greenness of food analytical methods using appropriate metrics and propose modification for a given protocol of food analysis • Describe challenges and propose solutions to the application of green analytical chemistry principles in food analysis
LO5. Effectively interpret, critique and communicate research in food	• Interpret, critique and present primary food analysis research literature to a scientific audience of peers • Concisely justify the use of a specific method for given analyses • Clearly describe and defend the design of experiments

analyses in written and oral forms	• Apply appropriate data visualization tools to display results (e.g., table vs graphs and different types of graphs) • Compare your results to those of relevant published literature

Resources

Textbook (required):

- "FOOD ANALYSIS", 2017, 5th edition. S. Suzanne Nielsen, Editor. Springer, New York (ISBN 978-3-319-45774-1). Available as eBook from the Carleton Library (https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/hgdufh/alma991023035122105153).

  Very Important Notes: There are two copies of ebook available in our library, meaning that only two users can access the ebook at the same time. A portion of the book can be downloaded for offline reading. Detailed policy regarding copy/print and download limits can be found here https://support.proquest.com/s/article/Ebook-Central-Per-User-Per-Day-Copy-print-and-download-limits?language=en_US

- Lecture videos created by the editor of the textbook: https://www.youtube.com/@baraemismail6563/videos

Useful Reference (optional):

- "FOOD ANALYSIS LABORATORY MANUAL", 2017, 3rd edition. S. Suzanne Nielsen, Editor. Springer, New York (ISBN 978-3-319-44125-2). Available as eBook from the Carleton Library (https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/hgdufh/alma991022627308905153).
- "SENSING TECHNIQUES FOR FOOD SAFETY AND QUALITY CONTROL", 2017. Xiaonan Lu, editor. The Royal Society of Chemistry, Croydon (ISBN: 978-1-78262-664-0). Available as eBook from the Carleton Library (https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/hgdufh/alma991022743324405153).
- "MODERN TECHNIQUES FOR FOOD AUTHENTICATION", 2018, 2nd edition. Dawen Sun, editor. Academic Press of Elsevier, Oxford (ISBN: 978-0-12-814264-6). Available as eBook from the Carleton Library (https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/hgdufh/alma991022668245805153).
- "DNA TECHNIQUES TO VERIFY FOOD AUTHENTICITY: APPLICATIONS IN FOOD FRAUD", 2020. Malcolm Burns, Lucy Foster, Michael Walker, editors. The Royal Society of Chemistry, Croydon (ISBN: 978-1-78801-178-5). Available as eBook from the Carleton Library (https://ocul-crl.primo.exlibrisgroup.com/permalink/01OCUL_CRL/hgdufh/alma991022950400505153).

Useful websites on food composition and analysis of food composition:

- AOAC International: http://www.aoac.org/
- Methods and Application of Food Composition Laboratory: Beltsville, MD

https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/methods-and-application-of-food-composition-laboratory/

- Nutrition Labelling, Nutrient Content Claims and Health Claims:
  CFIA Compliance Test to Assess the Accuracy of Nutrient Values
  http://www.inspection.gc.ca/english/fssa/labeti/nutricon/nutricone.shtml
  Health Canada. Guide to Developing Accurate Nutrient Values
  http://www.hc-sc.gc.ca/fn-an/label-etiquet/nutrition/reg/guide-nutri_val_tc-tm-eng.php

Assessment Activities

- Mid-term exam: 30%
- Paper Review: 10%
- Presentation: 15%
- Lab: 35%
- cuPortfolio: 10%

Details of Assessment Activities

Paper Reviews (10%, LO5)

There will be 3 paper reviews during the second part of the course for three advanced analytical techniques. Only the two with the highest marks will be included into the final grade. Students will work in pairs to interpret food analysis primary literature selected or a case formulated by the instructor. To demonstrate accurate interpretation of the literature, students will read the selected literature prior to class and work together in-class to answer a series of questions. Students will submit their work by 10 pm on the designated due date (details found in the table below for Tentative Schedule).

Program-level cuPortfolio (10%):

In this assignment, you will be asked to reflect on your learning experiences in food science courses, including this one, and begin to consider your academic, professional, and intellectual development throughout the Food Science program. We will dedicate one lecture session close to the end of the term for you to work on this assignment.

What is the purpose of this assignment? It is to challenge you to become more aware of your own learning and development as a Food Science student. As such, the reflection prompts are directly connected to the Food Science program-level learning outcomes. These outcomes describe what every student should be able to do as a result of completing the program and speak to the specific knowledge, skills, and abilities that students will develop.

Why reflect? Reflection requires you to think critically about your learning. It is not enough to simply achieve the learning outcomes for the program – the true value of your education lies in your ability to recognize, articulate, and synthesize what you have learned so that you can apply your learning post-graduation.

What is an artifact? You will also be asked to select pieces of evidence (artifacts) that demonstrate your developing competency in specific program learning outcomes and describe why these pieces best represent your knowledge, skills, abilities, and/or learning, such as assignments, presentations, lab reports, posters, review articles etc.

Midterm exam (30%, LOs 1-3):

This will be a closed-book exam with **a letter size (8.5"x11") hand-written "cheat sheet", double-sided**. This closed-book exam is to ensure that you have a comprehensive understanding of the content covered during the lectures. You do not need to memorize everything, but are expected to identify important information when you are asked to select and develop an analytical method for a specific food analysis problem, which is why a "cheat sheet" is allowed. The preparation of the "cheat sheet" is also a great way to help you review and summarize the content of lectures.

Remember to bring your **calculator**. Midterm exam will focus on content during Jan 8th – Feb 12th which is about proximate analysis and characterization of major food components.

Presentation (15%, LOs 4, 5):

In this assignment, you are asked to propose analytical methods that can tackle a persistent or emerging food integrity issue faced by the food industry. A list of ten food integrity issues will be provided for you to choose from, but you may work on issues off the list upon the discussion with and approval of the instructor. You will work in pairs and are expected to search the literature for a thorough understanding of the issue, list available/potential analytical methods for this issue, compare and analyze the performance of at least 3 different analytical methods and identify the most appropriate method or a group of methods. You are also expected to evaluate the greenness of the method. Based upon the literature search and analysis, you will develop a detailed experimental plan for sample collection and preparation/pretreatment, analytical procedures and results analysis for analyzing the particular issue. You will present the work to the class through **a written abstract** and a **20 min oral presentation** to introduce the food integrity issue and the importance of tackling it, as well as to explain and justify your experimental plan. *Each student will talk for ~10 mins, but the instructor will assign who is talking the first part one day before the presentation. So, both students in a pair should be familiar with the whole presentation during the preparation instead of only focusing on half of it.*

The presentation will be scheduled during the last lecture and the abstract should be submitted a week before the presentation (tentatively due on Apr 1st). Each presentation will be followed by a ~5 min question session. Each presentation will be evaluated by the instructor and fellow students. The presentation is worth 10%, abstract worth 3%, and peer evaluation on the participation during this assignment is worth 2%. The detailed breakdown of the marks and rubric for the evaluation of the written abstract and oral presentation can be found on Brightspace in the document "Presentation_Rubric.docx".

This assignment is to prepare you for real-world scenarios in which you are asked to design analytical methods to solve specific food integrity issues. You will practice and apply literacy skills to find relevant scientific literature, knowledge you learned in the class to evaluate the performance and greenness of

the methods described in the literature, critical thinking and integration skills to identify the most appropriate methods, as well as the scientific writing and presentation skills to effectively communicate your research findings with others. These skills and knowledge are not only important for food related research, but can be generally applied to many other fields such as chemistry, biology, biochemistry and pharmaceutical analysis.

Lab (35%):

There will be 5 labs in total to provide hands-on experiences for some of the techniques we learn during the lecture. Each lab is worth of 7% in the final grade. Details can be found in the lab section on Brightspace and will be discussed during the lab.

Technical checklist

iclicker account:

Please enroll to the Food Analysis through the link: https://join.iclicker.com/NQXG
We will use the iclicker platform to answer some questions during lecture. You can simply access iclicker using your computer or mobile phone.

Calculator:

Please prepare a calculator for the class. We will perform some calculation practices during the lecture. You need a calculator for the exam as well.

Tentative Schedule of Lectures

Date	Lecture Content	Related Textbook Chapters	Important dates for presentation assignment
Jan 8 & 10	Introduction of Food Analysis; Evaluation of Analytical Data; Sampling and Sample Preparation	1, 4, 5	
Jan 15 & 17	Overview of Proximate Analysis; Moisture and Total Solid Analysis; Ash Analysis	15, 16	A list of topics to be provided
Jan 22 & 24	Fat Analysis and Characterization	17, 23	
Jan 29 &	Protein Analysis	18, 24	
Jan 31	Carbohydrate Analysis and Characterization	19	
Feb 5 & 7	pH and Titratable Analysis; Mineral Analysis	21, 22	

Feb 12	Vitamin Analysis, Phenolics Analysis and Antioxidant Capacity in Food and Ingredients	20, 25	
Feb 14	Review		
Feb 26	Mid-Term		
Feb 28	Green Analytical Chemistry in Food Analysis	https://doi.org/10.1016/j.cogsc.2021.100522	Deadline to confirm the topic of selection
Mar 4	Overview of Spectroscopy, UV-Vis and Fluorescence Spectroscopy	6, 7	
Mar 6	Raman Spectroscopy	8	
Mar 11	Chemometric Analysis & Infrared spectroscopy	8	
Mar 13	Paper Review for spectroscopic technique		Deadline on Mar 17th, 10 pm
Mar 18	Chromatographic basics, LC, GC and MS	11-14	
Mar 20	Paper review for chromatography & MS		Deadline on Mar 24th, 10 pm
Mar 25	DNA-based Food Authentication	https://www.intechopen.com/chapters/66875 & https://pubs.acs.org/doi/10.1021/acs.jafc.8b07016	
Mar 27	Paper Review for DNA-based analysis		Deadline on Mar 31st, 10 pm
Apr 1	Enzymatic Methods and Immunoassays (guest talk)		Deadline for abstract submission
Apr 3	Program-level cuPortfolio		
Apr 8	Presentation		Deadline for finishing cuPortfolio

***Late submission Policy:**

- Late submission of each the paper review or case study will result in **losing 1.5% a day out of the 5%** total marks for each paper-review assignment.
- Late submission of the abstract for presentation will result in **losing 1% a day out of the 3%** total marks for abstract.

University Policies

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52

F = <50
WDN = Withdrawn from the course
ABS = Student absent from final exam
DEF = Deferred
FND = (Failed, no Deferred) = student could not pass even with 100% on final exam

Equal, Diverse and Inclusive Class Environment

Inclusive teaching statement

All students in the class, the instructor, and any guests should be treated with respect during all interactions. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback.

Land Acknowledgement

Here at Carleton University, it is important that we acknowledge that the land on which we gather is the traditional and unceded territory of the Algonquin nation.

Community Guidelines

The following values are fundamental to academic integrity and are adapted from the International Center for Academic Integrity*. In our course, we will seek to behave with these values in mind:

	As students, we will…	As a teaching team, we will…
Honesty	• Honestly demonstrate our knowledge and abilities on assignments and exams • Communicate openly without using deception, including citing appropriate sources	• Give you honest feedback on your demonstration of knowledge and abilities on assignments and exams • Communicate openly and honestly about the expectations and standards of the course through the syllabus, and with respect to assignments and exams
Responsibility	• Complete assignments on time and in full preparation for class • Show up to class on time, and be mentally/physically present • Participate fully and contribute to team learning and activities	• Give you timely feedback on your assignments and exams • Show up to class on time, and be mentally & physically present • Create relevant assessments and class activities
Respect	• Speak openly with one another, while respecting diverse viewpoints and perspectives • Provide sufficient space for others to voice their ideas	• Respect your perspectives even while we challenge you to think more deeply and critically • Help facilitate respectful exchange of ideas
Fairness	• Contribute fully and equally to collaborative work, so that we are not freeloading off of others • Not seek unfair advantage over fellow students in the course	• Create fair assignments and exams, and grade them in a fair, and timely manner • Treat all students equitably

Trust	• Not engage in personal affairs while on class time • Be open and transparent about what we are doing in class • Not distribute course materials to others without authorization	• Be available to all students when we say we will be • Follow through on our promises • Not modify the expectations or standards without communicating with everyone in the course
Courage	• Say or do something when we see actions that undermine any of the above values • Accept a lower or failing grade or other consequences of upholding and protecting the above values	• Say or do something when we see actions that undermine any of the above values • Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values

*This class statement of values is adapted from Tricia Bertram Gallant, Ph.D.

Special Information Regarding COVID-19

It is important to remember that COVID is still present in Ottawa. The situation can change at any time and the risks of new variants and outbreaks are very real. There are a number of actions you can take to lower your risk and the risk you pose to those around you including being vaccinated, wearing a mask, staying home when you're sick, washing your hands and maintaining proper respiratory and cough etiquette.

Please review the latest covid-19 guidance here: https://carleton.ca/covid19/.

Note About COVID-19 & Mental Health

The global pandemic has led to extra stress and uncertainty for everyone, and while we may all be experiencing the same storm, this does not mean that we are all in the same boat! If you are struggling, please do not hesitate to reach out. I am happy to listen, and/or direct you to resources that might help. In terms of class, if you need extra help or missed a lesson, don't stress! Email me and we will set a time to meet. I'll work with you, I promise. Remember that Carleton also offers an array of mental health and well-being resources, which can be found here.

Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University. More information can be found at: https://students.carleton.ca/course-outline/

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:

https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/

Academic Accommodations for Students with Disabilities

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca.

Religious Obligations

Please contact me with requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF, 2.1 MB).

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/

Accommodations for Missed Work

Carleton recognizes that students may be experiencing greater stress and other life factors that are not in their control. As a result, Carleton has put into place a protocol for students to apply for accommodations using a self-declaration form in the event of missed work. The form can be found at: https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf

**Note that these forms should be used for short-term concerns related to missed work; if you are experiencing chronic, ongoing challenges which necessitate a broader solution, I recommend reaching out to the Paul Menton Centre and/or the Care Support team.*

For Pregnancy

Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF, 2.1 MB).

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the Senate Policy on Accommodation for Student Activities (PDF, 25KB).

Academic Integrity

Academic Integrity is upholding the values of honesty, trust, respect, fairness, responsibility, and courage that are fundamental to the educational experience. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity.

(Adapted from Carleton University's Academic Integrity Policy, 2021).

Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams

Please review the checklist linked here to ensure you understand your responsibilities as a student with respect to academic integrity and this course.

Sanctions for Not Abiding by Carleton's Academic Integrity Policy

A student who has not upheld their responsibilities under Carleton's Academic Integrity Policy may be subject to one of several sanctions. A list of standard sanctions in science can be found here.

Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

Student Rights & Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the 7 Rights and Responsibilities Policy for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

Student Concerns

If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during office hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):

Note: You can also bring your concerns to Ombuds services.

Assistance for Students

Academic and Career Development Services: http://carleton.ca/sacds/
Writing Services: http://www.carleton.ca/csas/writing-services/
Peer Assisted Study Sessions (PASS): https://carleton.ca/csas/group-support/pass/
Math Tutorial Centre: https://carleton.ca/math/math-tutorial-centre/
Science Student Success Centre: https://sssc.carleton.ca/