

General information

Course: CHEM 498U
Section: 02
Term: Fall 2019
Credits: 3.0
Location: CC 314
Time: Wed 10:15 to 11:30
Fri 10:15 to 11:30

Instructor: Prof. Dajana Vuckovic
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Office hours: **Fridays 1-2 pm or by appointment**

Course Description

Calendar course description: Prerequisite: CHEM 271 AND 312 or permission from the instructor. This course presents the concepts, tools and common instrumental techniques employed in modern bioanalytical chemistry for the quantitative analysis of drugs, metabolites, toxins, environmental contaminants, biomarkers, proteins, biotherapeutics and/or DNA in biological samples. The main topics covered will include sample preparation; mass spectrometry; immunoassays; biosensors; microfluidics; bioanalytical method validation and discussion of emerging bioanalytical techniques and trends. The applications discussed will encompass toxicology, forensics, pharmacokinetics, metabolism, clinical chemistry, environmental analysis and biotechnology. Lectures and discussion-style tutorials.

Expanded course description: The main objective of this course is to teach students how to select or develop an analytical method for a given analyte in a given biological matrix. The students will be expected to understand the main principles of the stated techniques, and subsequently be able to compare/contrast different instrumental and non-instrumental approaches to select the most appropriate choice for a given analysis. To guide such critical interpretation, this course will heavily emphasize critical thinking and problem-solving skills through class discussions, problem-solving assignments and detailed exploration of case studies encompassing bioanalytical problems of current relevance such as newborn screening, clinical analysis of vitamin D, quality control of biotherapeutics and biosimilars and glucose monitoring.

Overall course goal: Select or design the analytical method to measure an analyte in biological fluid or tissue

Key learning objectives:

- Distinguish terminology of method validation and calibration
- Identify and explain the main principles of key techniques in bioanalysis
- Interpret data across different validation studies
- Design a validation study for a bioanalytical method in compliance with regulatory requirements
- Summarize and critique different analytical approaches to perform a selected analysis
- Propose a method for an analyte of interest in a given matrix

Grading scheme

Assignment 1	October 16, 2019	10%
Assignment 2	November 22, 2019	10%
Quizzes/in-class exercises	Throughout the course	10%
Participation	Throughout the course	10%
5-page critical evaluation term paper	Tuesday, December 3, 2019 at 17:00	20%
Final exam	TBD, during exam period Dec 5-19, 2019	40% (comprehensive)

Due dates and late policy:

→ Assignment due dates: **Assignments are due by 10:10 before the beginning of the class on the stated dates.**

→ Late policy on assignments and critical paper: **No late assignments will be accepted unless** medical note is provided. Any assignments that are not handed in by due date and time will be assigned a mark of **zero**. Assignments will **not** be accepted by email (unless pre-approved by the instructor). Only printed or hand-written solutions to the assignment will be accepted. Please hand in complete solution to the assigned problems, not just the final answers.

Textbook and materials:

- **Bioanalytical Chemistry, Mikkelsen and Corton, 2nd edition, Wiley, 2016 (required textbook for the course)**
 - Course notes and references described in weekly schedule for deeper information
 - Discussion papers – see page 4
 - FDA Bioanalytical Method Validation Guidelines:
<https://www.fda.gov/regulatory-information/search-fda-guidance-documents/bioanalytical-method-validation-guidance-industry>
 - scientific calculator

Textbooks (optional):

- Handbook of LC-MS Analysis, Li, Zhang and Tse, Wiley, 2013 (suggested textbook to complement some of LC-MS lectures)
- Bioanalysis of Pharmaceuticals, Hansen and Pedersen-Bjergaard, 2015 (suggested introductory textbook if you are struggling with basic background material)

MOODLE

All assignments and relevant course notes will be posted on Moodle course website. Please check the course website periodically to access these online materials. For any issues in terms of Moodle use please consult Helpdesk at extension 7613.

PARTICIPATION

Participation grade will be assigned at the end of the term based on the quality and quantity of your exchanges with your instructor and your peers in the class. You are expected to come prepared to the class which includes reading the materials before class and being prepared to discuss and critique the assigned readings. **Please**

note that participation and attendance are not equal. Attendance at every class will not result in full marks for participation unless you actively engage in class and group discussions of the material. Participation for this class may involve various forms throughout the term including: class discussions, group discussions and brainstorming, evaluation of your participation in groupwork by your group, class activities (both pair and group) and asking questions based on lecture material.

GOOD ADVICE

- do all questions on distributed assignments/homework questions
- do all assigned readings and come prepared to class
- prepare for discussion-style tutorials by reading the assigned journal article and critically thinking about it ahead of class time
- seek assistance well before the exam on any topics that are not clear to you

TENTATIVE SCHEDULE AND MAIN COURSE TOPICS (may be revised as needed):

Week	Topic	References/readings
Weeks 1-2	Biological samples Total protein, DNA, RNA and sugars spectroscopic methods Protein assay (discussion paper 1)	Lecture notes Mikkelsen and Corton, Chapter 2, Spectroscopic Methods for the Quantitation of Classes of Biomolecules
Week 3	Centrifugation and separation	Mikkelsen and Corton, Chapter 15, Centrifugation Methods
Weeks 4-5	Immunoassays and immunoassay discussion paper 2)	Mikkelsen and Corton, Chapter 6, Antibodies Mikkelsen and Corton, Chapter 7, Quantitative Immunoassays with Labels
Week 6	Sample preparation – classical, microextraction, dried blood spots	Li, Zhang and Tse, Chapter 13, Best practice in biological sample collection, processing and storage for LC-MS in bioanalysis of drugs Li, Zhang and Tse, Chapter 14, Best practice in biological sample preparation for LC-MS bioanalysis Li, Zhang and Tse, Chapter 30, Best practices in LC-MS method development and validation for dried blood spots
Week 7	Liquid chromatography	Mikkelsen and Corton, Chapter 16, Chromatography of biomolecules
Week 8	Mass spectrometry (2 guest lectures by Dr. English)	Mikkelsen and Corton, Chapter 17, Mass Spectrometry of Biomolecules
Week 9	Bioanalytical method validation and regulatory requirements	FDA Bioanalytical Method Validation Guidelines Li, Zhang and Tse, Chapter 20, Evaluation and elimination of matrix effects in LC-MS bioanalysis Mikkelsen and Corton, Chapter 19, Validation of New Bioanalytical Methods

Week 10	LC-MS of drugs, toxins and metabolites LC-MS of endogenous biomarkers LC-MS discussion paper 3	Quantitative determination of endogenous compounds in biological samples using chromatographic techniques, Nico Merbel, TrAC, 2008, http://www.sciencedirect.com/science/article/pii/S016599360800191X
Week 11	LC-MS of proteins and biotherapeutics LC-MS discussion paper 4	Lange et al. Selected reaction monitoring for quantitative proteomics: a tutorial http://msb.embopress.org/content/msb/4/1/222.full.pdf
Week 12	Microfluidics	The present and future role of microfluidics in biomedical research, Eric K. Sackmann, Anna L. Fulton & David J. Beebe, Nature, 2014, http://www.nature.com/nature/journal/v507/n7491/pdf/nature13118.pdf
Week 13	Biosensors Biosensor discussion paper 5	Glucose Biosensors: An Overview of Use in Clinical Practice, Eun-Hyung Yoo and Soo-Youn Lee 2, <i>Sensors</i> 2010 , <i>10</i> , 4558-4576; doi:10.3390/s100504558 Mikkelsen and Corton, Chapter 8, Biosensors

DISCUSSION PAPER SCHEDULE

1	Fast and Sensitive Total Protein and Peptide Assays for Proteomic Analysis, J. Wisniewski and F. Gaugaz, <i>Analytical Chemistry</i> , 2015, 87, 4110-4116 http://pubs.acs.org/doi/abs/10.1021/ac504689z
2	Sandwich Assay for Tacrolimus Using 2 Anti-Tacrolimus Antibodies T.Q. Wei, Y.F. Zheng, M. Dubowy, and M. Sharma, <i>Clinical Chemistry</i> , 2014, 60, 621-30 www.clinchem.org/content/60/4/621.full
3	Analysis and quantification of vitamin D metabolites in serum by ultra-performance liquid chromatography coupled to tandem mass spectrometry and high-resolution mass spectrometry – a method comparison and validation, Bruce et al, <i>Rapid Communications in Mass Spectrometry</i> , 2013, 27, 200–206, http://onlinelibrary.wiley.com/doi/10.1002/rcm.6439/epdf
4	Quantitative Insulin Analysis Using Liquid Chromatography–Tandem Mass Spectrometry in a High-Throughput Clinical Laboratory, Z Chen, MP Caulfield, MJ McPhaul, RE Reitz, SW Taylor, NJ, Clarke, <i>Clinical Chemistry</i> , 2014, 59, 1349-56 http://www.clinchem.org/content/59/9/1349.full.pdf+html
5	Detection of Antibodies in Blood Plasma Using Bioluminescent Sensor Proteins and a Smartphone, Remco Arts, Ilona den Hartog, Stefan E. Zijlema, Vito Thijssen, Stan H. E. van der Beelen, Maarten Merckx, <i>Analytical Chemistry</i> , 2016, 88, 4525-4532 http://pubs.acs.org/doi/pdf/10.1021/acs.analchem.6b00534

MANDATORY QUIZ AND SEMINAR

As part of this course, you are **required** to i) attend a Chemistry and Biochemistry Departmental Seminar on the academic conduct code and the appropriate use of information sources and ii) pass the online quiz associated with this seminar (the passing grade for the quiz is 100%). (**Note:** This is **not** the University's quiz you may have been asked to take when you first registered and logged into the myConcordia portal; the one you must take is similar, but graded by the Department of Chemistry and Biochemistry, and you do not have access to it until after you have attended the seminar.) The aim of this seminar is to clarify the academic conduct code in terms of what practices will be considered unacceptable with regards to work submitted for grading in Chemistry and Biochemistry courses. **You are only exempt from repeating the seminar and the quiz if you have done both in Fall 2014 or more recently,*** otherwise you are required to repeat both this term. This short seminar (1 hour) will be held at the following times (note that late-comers will **not** be admitted):

Date (Fall 2019)	Time	Room
Monday, Sept. 16	16:45-17:45	CC 111
Tuesday, Sept. 17	16:45-17:45	CC 308
Tuesday, Sept. 17	20:45-21:45	HB 130
Wednesday, Sept. 18	16:45-17:45	CC 308
Wednesday, Sept. 18	20:45-21:45	HB 130
Thursday, Sept. 19	16:45-17:45	HC 155
Friday, Sept. 20	16:45-17:45	HC 157

As space for each of the seminars is limited by the room size, please **sign up** to your preferred time as soon as possible (slots fill up quickly). Sign-up sheets are available two weeks in advance of the seminars outside SP 201.01 (Departmental office). Only sign up in **available slots**: rooms must not be filled over capacity!

If you do not complete this course requirement, your final grade for the course may be lowered by one full letter grade with an incomplete (INC) notation until such time as this requirement is completed. Please refer to the undergraduate calendar (section 16.3.5) for details on removal of an incomplete notation.

* You are exempt if you can locate your ID in the pdf file located on the Departmental web site (<http://www.concordia.ca/content/dam/artsci/chemistry/docs/Compliance-list.pdf>).

PLAGIARISM AND OTHER FORMS OF ACADEMIC DISHONESTY

The Academic Code of Conduct can be found in section 17.10 of the academic calendar (<http://www.concordia.ca/academics/undergraduate/calendar/current/17-10.html>). Any form of unauthorized collaboration, cheating, copying or plagiarism found in this course will be reported and the appropriate sanctions applied. The mandatory seminar is a clear and fair opportunity to learn what our faculty regards as academic misconduct. Failure to take part in this learning opportunity and thus ignorance of these regulations is no excuse and will not result in a reduced sanction in any case where academic misconduct is observed.