DEPARTMENT OF BIOCHEMISTRY

BCHM 62000 – Protein Mass Spectrometry, Proteomics, and Metabolomics
Spring, 2020

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COURSE OBJECTIVES

This is a two credit course. The goals of this course are to introduce students to
1) basic principles of mass spectrometry, 2) common instruments used for
protein mass spectrometry, 3) the most common applications of protein mass
spectrometry in biological research, 4) current approaches to quantitative protein
mass spectrometry and their use in proteomic and metabolomic studies 5) the
skills necessary to analyze mass spec data from a variety of experiment types
including the ability to use and understand common database search programs,
and 6) contemporary issues associated with large-scale
proteomics/metabolomics experiments (including technical challenges and
limitations) culminating in the ability to design appropriate experiments to answer
a specific omics question.

LEARNING OUTCOMES

BCHM 62000 students will be knowledgeable in practical skills associated with
mass spectral analysis of biological molecules, with a heavy emphasis on
proteins.

BCHM 62000 students will understand the basics of experimental design for the
mass spectral analysis of proteins and other biological molecules.

BCHM 62000 students will acquire an appreciation for current instrumentation
and methods commonly used in protein mass spectrometry and the advantages
and disadvantages of each.

BCHM 62000 students will be able to read and critically evaluate primary
literature pertaining to proteomic and metabolomic studies.
TEXTBOOK

There is no textbook for this course. Assigned reading material will be provided via the course Blackboard page (see below).

TIME AND PLACE

Tuesday and Thursday 10:30-11:20, BCHM 102

Attendance policy:
Please let me know ahead of time if you will have to miss a class. Since this is a small class and there will be extensive discussion and class participation at times, and because the majority of exam material will come from the class lectures, it is important for students to attend each class. I will allow two unexcused absences, and then each additional unexcused absence will result in a deduction of 5 points from the final grade. Excused absences must be requested ahead of time and may require official documentation at the discretion of the instructor verifying why the class must be missed.

BLACKBOARD

The course syllabus, PowerPoint lecture files, assigned reading material, answer keys for homework sets and the mid-term exam, and any additional course information will be available on the course Blackboard webpage.

ASSESSMENT

Exams:
There will be one mid-term exam in the evening of Wednesday, March 11. The second/final exam will be in the evening of Monday, April 20. It will be partially cumulative but will focus more on material from the second half of the class.

Homework Sets:
Because a major goal of this course is to provide students with the skills necessary to analyze mass spectrometric data for a variety of experiment types, there will be homework problem sets during the semester given out at 2-3 week intervals that give students a chance to practice data analysis as well as solidify their understanding of basic principles and instrumentation. Students will have one week to complete each set.

Grading Policy:
- Mid-term and final exam will count 30% and 40% of the final grade, respectively.
- Homework sets collectively will count for 30% of the final grade.

The following grading scale will be used:
92-100 = A
90-91 = A-
88-89 = B+
82-87 = B
80-81 = B-
78-79 = C+
72-77 = C
70-71 = C-
60-69 = D
below 60 = F

I reserve the right to apply grading curves to any of the tests and homework sets but there will not automatically be a defined curve.

Missing a homework assignment will result in a grade of 0 being recorded unless documented justification is presented.

If you have any disagreements with the way any of your assignments have been graded, please make an appointment to see the instructor.

Requests for re-grades must be submitted no later than the end of the second class period after the grade is received.

EXTRA CREDIT

There will be no opportunity for extra credit.

OBTAINING EXTRA HELP

The instructor will be available to answer questions immediately after class or by appointment (arranged in class or by e-mail). Alternatively, you can submit questions by e-mail.

ON-LINE COURSE EVALUATIONS

During the last two weeks of the semester, you will be provided an opportunity to evaluate this course and your instructor. Purdue now uses online course evaluations. At the end of the semester you will receive an official email from evaluation administrators with a link to the online evaluation site. You will have a couple weeks to complete this evaluation. Your participation in this evaluation is an integral part of this course. Your feedback is vital to improving education at Purdue University. I strongly urge you to participate in the evaluation system.
ACADEMIC MISCONDUCT

The Purdue Honors Pledge:
All students in the course are expected to behave in a manner consistent with the Purdue Honors Pledge:
https://www.purdue.edu/provost/teachinglearning/honor-pledge.html
“As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.”

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

To provide you with an unambiguous definition of academic misconduct, the following text has been excerpted from "Academic Integrity: A Guide for Students", written by Stephen Akers, Ph.D., Executive Associate Dean of Students (1995, Revised 1999, 2003), and published by the Office of the Dean of Students in cooperation with Purdue Student Government, Schleman Hall of Student Services, Room 207, 475 Stadium Mall Drive West Lafayette, IN 47907-2050.

“Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations]
Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal crib, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

More specifically, the following are a few examples of academic dishonesty which have been discovered at Purdue University.

- substituting on an exam for another student
- substituting in a course for another student
- paying someone else to write a paper and submitting it as one's own work
- giving or receiving answers by use of signals during an exam
- copying with or without the other person's knowledge during an exam
- doing class assignments for someone else
- plagiarizing published material, class assignments, or lab reports
- turning in a paper that has been purchased from a commercial research firm or obtained from the internet
- padding items of a bibliography
- obtaining an unauthorized copy of a test in advance of its scheduled administration
• using unauthorized notes during an exam
• collaborating with other students on assignments when it is not allowed
• obtaining a test from the exam site, completing and submitting it later
• altering answers on a scored test and submitting it for a regrade
• accessing and altering grade records
• stealing class assignments from other students and submitting them as one's own
• fabricating data
• destroying data or stealing the work of other students

Plagiarism is a special kind of academic dishonesty in which one person steals another person's ideas or words and falsely presents them as the plagiarist's own product. This is most likely to occur in the following ways:

• using the exact language of someone else without the use of quotation marks and without giving proper credit to the author
• presenting the sequence of ideas or arranging the material of someone else even though such is expressed in one's own words, without giving appropriate acknowledgment
• submitting a document written by someone else but representing it as one's own

Course Policy Towards Academic Misconduct: Any incidence of academic misconduct on an individual assignment, including but not necessarily limited to the examples above, will result in a grade of 0 on that assignment and will be reported to the Purdue Office of Student Rights and Responsibilities for evaluation and possibly more extensive disciplinary action.

PURDUE DISCRIMINATION POLICY
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Purdue’s nondiscrimination policy can be found at: http://www.purdue.edu/purdue/ea_eou_statement.html

CAPS INFORMATION:
Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.
EMERGENCY PREPAREDNESS

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. To get information about changes in this course consult the class Blackboard site or e-mail or phone the instructor.

Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Please review the following procedures:

• For any emergency call 911.
• There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.
• If we hear a fire alarm we will immediately evacuate the building through the North entrance and proceed to the opposite side of South University St, outside the WSLR building entrance.
• If we are notified of a Shelter in Place requirement for a tornado warning we will shelter in the lowest level of this building away from windows and doors. Our preferred location is directly down the North stairwell to the BCHM basement.
• If we are notified of a Shelter in Place requirement for a hazardous materials release we will shelter in our classroom shutting any open doors and windows.
• If we are notified of a Shelter in Place requirement for an active threat such as a shooting we will shelter in a room that is securable preferably without windows. Our preferred location is across the hall in BCHM 105.

Attached to the syllabus is an “Emergency Preparedness for Classrooms” sheet that provides additional preparedness information. Please review the sheet and the Emergency Preparedness website for additional emergency preparedness information.
LECTURE SCHEDULE

CLASS 1 – Tuesday, January 14
Introduction; course outline and goals; the Syllabus; Proteomics and Metabolomics; Brief history of mass spectrometry (MS)

CLASS 2 – Thursday, January 16
Understanding the mass spectrum; basic principles of MS

CLASS 3 – Tuesday, January 21
MS instrumentation: ionization sources and mass analyzers

CLASS 4 – Thursday, January 23
MS instrumentation – tandem MS configurations and introduction to ion fragmentation

CLASS 5 – Tuesday, January 28
Peptide ion fragmentation and generating peptides for MS analysis

CLASS 6 – Thursday, January 30
Protein MS applications – identifying unknown proteins by peptide mass fingerprinting; An introduction to database search algorithms

CLASS 7 – Tuesday, February 4
Protein MS applications – de novo sequencing of peptides from fragment ion spectra obtained by tandem MS; Homology searching

CLASS 8 – Thursday, February 6
Protein MS applications – identifying unknown proteins from tandem MS data by database search algorithms

CLASS 9 – Tuesday, February 11
Protein MS applications - identification of post-translational modifications from tandem MS data

CLASS 10 – Thursday, February 13
Protein MS applications – identification of post-translational modifications using specialized analyses, focusing on protein phosphorylation

CLASS 11 – Tuesday, February 18
Challenges with PTM mapping; Tools for scoring PTM assignments; Practice with manual analysis of tandem MS data for PTM mapping

CLASS 12 – Thursday, February 20
Quantitative MS – Absolute and relative quantification of biomolecules using stable isotope labeling

CLASS 13 – Tuesday, February 25
Quantitative MS - Label-free approaches to quantification of biomolecules

CLASS 14 – Thursday, February 27
Dealing with complex samples – protein and peptide separation technologies

CLASS 15 – Tuesday, March 03
Sample preparation for proteomics and protein MS

CLASS 16 – Thursday, March 05
Tools for analysis and interpretation of large-scale proteomics data, including quantitative analyses - MaxQuant

CLASS 17 – Tuesday, March 10
Question and answer session for mid-term exam with additional practice problems (by TAs)

Mid-term Exam – Wednesday, March 11
08:00p - 10:00p, ARMS 1109

CLASS 18 – Thursday, March 12
No class

SPRING BREAK

CLASS 19 – Tuesday, March 24
Bioinformatics tools: extracting biological meaning from proteomic experiments

CLASS 20 – Thursday, March 26
Introduction to metabolomics

CLASS 21 – Tuesday, March 31
Targeted and untargeted metabolomics

CLASS 22 – Thursday, April 02
Bioinformatics tools in metabolomics

CLASS 23 – Tuesday, April 07
Practical considerations for designing proteomic/metabolomics experiments; Specialized MS applications; Examples of biological MS as an analytical tool

CLASS 24 – Thursday, April 09
The future of proteomics/metabolomics: upcoming technologies, challenges to overcome in the field, new and improved applications; Alternative experimental approaches for proteomics/metabolomics

CLASS 25 – Tuesday, April 14
Critical literature reviews

CLASS 26 – Thursday, April 16
Critical literature reviews

Final Exam – Monday, April 20
08:00p - 10:00p, ARMS 1109