CLINICAL & APPLIED MASS SPECTROMETRY (CAMS)

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CAMS 401 Theory and Physics of Mass Spectrometry (4 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will cover the fundamental physical principles that are used in mass spectroscopy, with a primary focus on basic electricity and magnetism theory. This course will not be calculus based.
Outcomes:
At the end of this course students will be able to: 1) Describe the fundamental principles of Newton's Laws and Conservation of Energy; 2) Describe basic interactions between charged particles and electric fields; 3) Define electric potentials; 4) Describe the relationship between electric and magnetic fields; 5) Identify the direction a charged particle will move in a magnetic field; and 6) Derive the relationship between charge, mass and velocity

CAMS 402 Chemistry of Protein Separation (4 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will cover the fundamentals of separating biological agents in solution for analysis by mass spectrometry.
Outcomes:
At the end of this course students will be able to: 1) Describe the composition of typical biological collections including blood and waste; 2) Describe best-practices for preparing collections for mass spectrometry; 3) Describe fundamentals of separating biomolecules according to size, charge and other physiochemical factors; and 4) Describe mechanisms and tradeoffs behind common approaches for separating biological samples via chromatography (liquid and gas)

CAMS 403 Introduction to Mass Spectrometry Instrumentation (2 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will introduce the mass spectrometry instrumentation that is utilized in clinical, pharma, and academia, including HPLC and other sample preparation instrumentation.
Outcomes:
At the end of this course students will be able to: 1) Describe the basic technologies and instrumentation currently used for mass spectrometry; 2) Understand the basics in how to operate this instrumentation (theory, no hands on); 3) Appreciate the similarities and differences in the different technologies, and in what situation each instrument would be most appropriate; and 4) Describe the instrumentation used in sample preparation

CAMS 411 Computation and Bioinformatics for Proteomics (3 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will cover the governing principles of analyzing proteomics data, with a special emphasis on data derived from mass spectrometry (MS). Computational methods and tutorials will complement the theoretical material.
Outcomes:
At the end of this course students will be able to: 1) Describe key approaches for matching MS spectra to known proteins, as well as identifying and quantifying protein content in analyzes samples; 2) Describe methodologies and limitations thereof for labeling and quantifying proteins of interest; 3) Perform routine computational analyses of MS data using python; and 4) Describe best-practices for objective data analysis and reproducibility

CAMS 412 Clinical Considerations and Biomarker Development (3 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will cover fundamental concepts about the criteria for something to qualify as a biomarker and how they are analyzed by mass spectrometry from a variety of biological fluids and/or tissues. We will also discuss the broader uses of mass spectrometry in a clinical or hospital setting.
Outcomes:
At the end of this course students will be able to: 1) Compare and contrast aspects of good vs bad biomarkers and the utility of mass spectrometry for their detection in biological samples; 2) Describe best practices for sample collection and the limitations of using biological samples; 3) Describe current regulations and standards for biomarker use in the clinic; 4) Identify and describe biohazard safety issues when working with biological samples; 5) Describe analytical approaches for quantification of biomarkers; and 6) Describe the type of mass spectrometry assays typically used in a clinical or hospital setting

CAMS 413 Advanced Mass Spectrometry Approaches (2 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will cover advanced MS approaches to address specialized needs. These approaches will frequently require specific instrumentation, and bioinformatics approaches, but sometimes only involve changes to sample preparation and interpretation.
Outcomes:
At the end of this course students will be able to: 1) Understand the need for specialized mass spec approaches; 2) Appreciate the theory behind specialized mass spec approaches; 3) Describe the technical and practical considerations when utilizing specialized MS approaches; and 4) Be able to choose the correct advanced MS approach for a particular situation

CAMS 491 Mass Spectrometry Lab Rotation A (5 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will be a hands-on intensive laboratory rotation. Students will learn how to prepare samples that are "mass spec ready" from a variety of liquid and solid tissue biological samples. Students will learn quality control parameters and will produce high quality samples for use in the HPLC and mass spectrometer.
Outcomes:
At the end of this course students will be able to: 1) Process liquid and tissue biological samples for analysis by mass spectrometry; 2) Perform gel electrophoresis on prepared samples and excise selected gel bands; 3) Perform in in-gel digestions using standard enzymatic approaches; 4) Perform in-solution digestions using standard enzymatic approaches; 5) Quantify protein samples before and after digestion; and 6) Use column chromatography to generate high purity samples

CAMS 492 Mass Spectrometry Lab Rotation B (5 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
This course will be a hands-on intensive laboratory rotation. Students will learn how to perform normal LC-mass spectrometer general upkeep including HPLC setup, mass spectrometer calibration, quality control, etc. Students will then learn the process of running mass spectrometers for two types of approaches: discovery and targeted mode.
Outcomes:
At the end of this course students will be able to: 1) Setup HPLC, mass spectrometer and software; 2) Perform normal instrument upkeep including calibration, quality control, solution changes; 3) Be able to troubleshoot common instrument issues; 4) Analyze sample on mass spectrometer for discovery (two group comparison); 5) Analyze sample on mass spectrometer for targeted quantification (in simple solution); 6) Use bioinformatics software packages to analyze data from mass spectrometers; and 7) Understand how to present mass spectrometry data

CAMS 493 Capstone Design - Applications in Mass Spectrometry A (2 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
During the course students will develop a written research proposal using mass spectrometry as the primary experimental approach to test their hypotheses. Students can choose from any relevant topic of interest such as the analysis of clinical biomarkers in disease, environmental endocrine disruptors, industrial pollutants, waste water contamination, etc. The topic must be approved by the student's advisor in advance.
Outcomes:
At the end of this course students will be able to: 1) Design quantitative experiments using mass spectrometry; 2) Describe and identify appropriate experimental positive and negative controls; 3) Describe statistical analyses relevant for their experimental design; 4) Discuss limitations and pitfalls of their research approach and describe alternatives; and 5) Critically evaluate the current literature and describe the rationale for their research study

CAMS 494 Capstone Design - Applications in Mass Spectrometry B (2 Credit Hours)
Pre-requisites: Enrollment in CAMS-MS program
During the course students will develop a written research proposal using mass spectrometry as the primary experimental approach to test their hypotheses. Students can choose from any relevant topic of interest such as the analysis of clinical biomarkers in disease, environmental endocrine disruptors, industrial pollutants, waste water contamination, etc. The topic must be approved by the student's advisor in advance.
Outcomes:
At the end of this course students will be able to: 1) Design quantitative experiments using mass spectrometry; 2) Describe and identify appropriate experimental positive and negative controls; 3) Describe statistical analyses relevant for their experimental design; 4) Discuss limitations and pitfalls of their research approach and describe alternatives; and 5) Critically evaluate the current literature and describe the rationale for their research study