HEALTH SCIENCES

Graduate Programs

- Biomedical Sciences (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/)
- Biochemistry and Molecular Biology (MS) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/biochemistry-molecular-biology-ms/)
- Biochemistry, Molecular and Cancer Biology (PhD) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/biochemistry-molecular-biology-phd/)
- Cell and Molecular Physiology (MS) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/cell-molecular-physiology-ms/)
- Cell and Molecular Physiology (PhD) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/cell-molecular-physiology-phd/)
- Cell and Molecular Physiology (MD/PhD) (https://catalog.luc.edu/graduate-professional/dual-degree-programs/biochemistry-molecular-biology-md-phd/)
- Molecular Pharmacology and Therapeutics (MS) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/molecular-pharmacology-therapeutics-ms/)
- Molecular Pharmacology and Therapeutics (PhD) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/molecular-pharmacology-therapeutics-phd/)
- Molecular Pharmacology and Therapeutics (MD/PhD) (https://catalog.luc.edu/graduate-professional/dual-degree-programs/molecular-pharmacology-and-therapeutics-md-phd/)
- Neuroscience (MS) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/neuroscience-ms/)
- Neuroscience (PhD) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/neuroscience-phd/)
- Neuroscience (MD/PhD) (https://catalog.luc.edu/graduate-professional/dual-degree-programs/neuroscience-md-phd/)
- Pharmacology/Business (MS/MBA) (https://catalog.luc.edu/graduate-professional/dual-degree-programs/pharmacology-business-ms-mba/)
- Pharmacovigilance Certificate (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/biomedical-sciences/pharmacovigilance-certificate/)
- Neiswanger Institute of Bioethics and Healthcare Leadership (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/)
- Bioethics and Health Policy (DBe) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/bioethics-dbe/)
- Bioethics and Health Policy (MA) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/bioethics-health-policy-ma/)
- Bioethics and Health Policy Certificate (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/bioethics-health-policy-certificate/)
- Healthcare Mission Leadership (DHCMML) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/healthcare-mission-leadership-dhcmml/)
- Healthcare Mission Leadership (MA) (https://catalog.luc.edu/graduate-professional/graduate-school/health-sciences/neiswanger-institute-bioethics/healthcare-mission-leadership-ma/)

Bioethics & Healthcare Leadership (BEHL)

BEHL 401 Clinical Topics in Bioethics (3 Credit Hours)

This course provides an overview of the major areas of clinical biomedical ethics guided by extensive use of case discussions and analysis which will help to develop ethical problem-solving skills.

Course equivalencies: IPS 651/BEHP 401/BEHL 401
BEHL 402 Justice & Health Care (3 Credit Hours)
This course provides an overview of justice and health care with special emphasis upon the developing world by examining prevailing theoretical frameworks and how justice is played out in various health care systems.

BEHL 403 Ethics Care Continuum (3 Credit Hours)
This course prepares students to identify biomedical ethics issues in settings such as long-term care, rehabilitation care, dentistry, and alternative medicine, and to develop moral frameworks for addressing these issues.

BEHL 404 Biomedical Ethics and Law (3 Credit Hours)
This course serves as an introduction to biomedical ethics and the law and will introduce the history of bioethics and the US legal system by surveying a number of seminal legal cases.

BEHL 405 Research and Ethics (3 Credit Hours)
This interactive seminar will explore the responsible conduct of science with a focus on ethical issues in clinical research involving human participants.

BEHL 406 Principles of Health Care Ethics (3 Credit Hours)
This course provides an overview of important theories in bioethics and will examine major works by leading bioethics scholars to become more familiar with different approaches in the field.

BEHL 407 Social Determinants of Health and Bioethics (3 Credit Hours)
This course will review the theoretical work on social science (anthropology, sociology) and moral reasoning as it pertains to the discipline of bioethics, its philosophical roots, and the body of social science works in bioethics.

BEHL 408 Ethics, Genetics and Health Policy (3 Credit Hours)
This course provides an introduction to genetic ethics and a survey of topics that constitute the professional and popular literature in the field.

BEHL 409 Religion and Bioethics (3 Credit Hours)
This course is a thematic exploration of religion and bioethics with a specific concentration on its implications at the end of life.

BEHL 410 Ethics Consultation (1-3 Credit Hours)
This is a two-month course of online learning which includes a 3-day on-campus intensive experience for students including didactic sessions and ethics consultation skills development.

BEHL 411 Public Health Ethics (3 Credit Hours)
This course introduces current ethical issues in public health research, practice, and policy.

BEHL 412 Organizational Ethics: Business, Professionalism, and Justice (3 Credit Hours)
This course examines ethical issues in health care from the vantage point of decision makers who shape the system, e.g., physicians, health system administrators, community advocates, etc. Course equivalencies: IPS 652/BEHP 412/BEHL 412

BEHL 413 History of Medicine and Bioethics (3 Credit Hours)
This course seeks to situate and examine the emergence and development of the field of bioethics within the history of medicine and the ethical concerns embodied in medicine's practice.

BEHL 414 Moral Theology for Bioethics (3 Credit Hours)
This course provides an introduction to Catholic moral theology through a historical review of its development and a consideration of key documents, events, arguments and concepts beginning with the scriptural witness of Christ and concluding with the moral teaching of John Paul II as it bears upon contemporary Catholic moral theology. Outcomes: Its goal is to assist in establishing an historical and theoretical foundation for those who are interested in bioethics as it is considered and practiced in the Catholic tradition.

BEHL 415 Ethical & Religious Directives for Catholic Healthcare Leadership (3 Credit Hours)
This course offers a topical survey of bioethical issues pertinent to clinical practice in the Catholic context. The United States Conference of Catholic Bishops' document, Ethical and Religious directives for Catholic Health Care Services, 5th Edition, serves as the guiding document of the course. Topics and concepts considered include abortion, contraception, sterilization, nutrition and hydration, withdrawal of life support, care of the dying, cooperation, conscience, human dignity and personhood. Course equivalencies: IPS 654/BEHP 415/BEHL 415

BEHL 416 Catholic Bioethics and Social Justice (3 Credit Hours)
This course involves an historical study of the development of the body of official Catholic Social Teaching (CST) specific to its impact on healthcare delivery in the United States. Current developments in select key social issues and movements are also addressed insofar as those issues and movements influenced healthcare delivery. The pastoral letters of the U.S. Bishops, especially their teachings on healthcare reform, also receive attention. The interface between religious faith and public policy debates is a constant concern throughout the course. Practical strategies for fostering a social justice consciousness in healthcare settings are also considered. Course equivalencies: IPS 655/BEHP 416/BEHL 416

Outcomes:
Extensive use of case discussion and analysis will help to develop the participants' understanding of the principles of CST and their application to the healthcare context.

BEHL 417 Narrative Ethics (3 Credit Hours)
This course will consider a major theoretical framework in bioethics that has emerged as a serious alternative to principle-based bioethics. In this course, students will gain an understanding of what narrative bioethics is, read theoretical texts related to narrative ethics, and also read a variety of narratives that relate to medicine and healthcare (stories, films, etc). The role of narrative in the ethics consultation process will also be explored. Outcomes:
This course aims to equip students with a sophisticated understanding of narrative and the role it plays in medicine and bioethics.
BEHL 418 Advancing Health Equity Practice (3 Credit Hours)
This course introduces the frameworks and practice of health equity as it pertains to the field of bioethics. The tools and materials help students more effectively incorporate health equity into all aspects of their work. Topics include: community health, multi-sector community engagement, and innovative approaches to clinical and community work to improve populations health.
Course equivalencies: IPS 656/BEHP 418 / BEHL 418
Outcomes:
Effectively incorporate health equity into all aspects of bioethics practice

BEHL 419 Organizational Ethics II: Ethical Leadership for Changing Healthcare Environment (3 Credit Hours)
This course examines the theory, role, and elements of leadership that effectively serve non-profit healthcare systems. In particular, the nature of leadership is examined. Questions of leadership style and theories of what constitutes effective leadership are considered.
Course equivalencies: IPS 653/BEHP 419/BEHL 419
Outcomes:
Key focus on communication strategies and methods of organizational change

BEHL 420 Advanced Topics in Bioethics and Law (3 Credit Hours)
This class will explore the historical relationship between law and bioethics and examine how law and bioethics come together or may be at odds. Recognize/discuss changing nature of physician-patient relationship, continuing evolution of informed consent, intersection of commerce and science, changing definition of death, growing complexity of reproduction.
Outcomes:
Resolve dilemmas raised by changing biotechnology

BEHL 421 Practicum in Clinical Ethics (3 Credit Hours)
Pre-requisites: Department Consent Required Outcomes: This practicum will expose students to the practical applications of clinical ethics. The goal of the clinical ethics practicum is to provide doctoral students on the clinical ethics track the opportunity to use knowledge and skills acquired in the academic program in a clinical setting (e.g. community hospital or academic medical center), under the direction of a preceptor at that setting.

BEHL 422 Practicum in Organizational/Public Health Ethics (1-3 Credit Hours)
Pre-requisites: BEHL 419
The practicum will enable the student to work on a project which translates both general and discipline-specific information into organizational ethics or public health practice. Students must demonstrate the capacity to utilize knowledge and make evidence-based decisions regarding these topics, and exhibit leadership, creativity, and the ability to work well with others.
Outcomes:
Goal of the practicum is to provide students the opportunity to use knowledge and skills acquired in the academic program in a professional setting under the direction of a preceptor

BEHL 423 Doctoral Capstone I (3 Credit Hours)
Pre-requisites: Oral and Written Qualifying Exams
This course is an opportunity for doctoral students in our program to further develop a paper from their practicum experience and/or another course and revise it into a manuscript of publishable quality.
Outcomes:
Publishable peer-reviewed paper

BEHL 424 Doctoral Capstone II (3 Credit Hours)
Pre-requisites: BEHL 423
This course is an opportunity for doctoral students in our program to further develop a paper from their practicum experience and/or another course and revise it into a manuscript of publishable quality.
Outcomes:
Students will be required to appear on campus for a capstone presentation with faculty

BEHL 425 Empirical Bioethics (3 Credit Hours)
Provides an overview of empirical research in the increasingly interdisciplinary field of bioethics. Will examine the relationship between empirical data and normative claims and potential pitfalls that may arise when using information about what (is) to determine what (ought) to be done.
Outcomes:
Students will gain familiarity with the range of quantitative and qualitative research methods used in bioethics as well as academic disciplines, understanding of empirical studies on ethical problems in medicine, public health policy, and clinical research; Discussions will be relevant to a range of professional settings

BEHL 426 Ignatian Spirituality and Medicine (3 Credit Hours)
This course in will explore the roots of Ignatian Spirituality as presented in the Spiritual Exercise and other writings of Ignatius Loyola and the early Jesuits. From this historical starting point, the course will shift to explore key themes that have emerged from this spiritual tradition as it relates to medicine, paying special attention to the Spiritual Exercises.
Outcomes:
This course aims to assist students in establishing a substantive understanding of Ignatian spirituality and the tradition of Jesuit education in which they participate as a means for leading faithful, joyful, and hopeful lives as physicians

BEHL 427 Professionalism and Professional Ethics (3 Credit Hours)
This course will review and critically examine the professional codes of ethics of a variety of health-related professions: medicine, nursing, dentistry, social work, chaplaincy, risk management, and allied health. We will examine the growth of professionalism as a movement and answer questions related to this topic.
Outcomes:
Understand what is a profession, what are professional ethics; Difference between common morality and professional ethics, and difference between applied ethics and professional ethics; We will also discuss whether a pan-professional ethics code is needed for the health care professions

BEHL 428 Writing and Scholarship Skills (3 Credit Hours)
Writing skills are an essential form of communication not only between the instructor and students but also among and between the students themselves. Topics covered: Academic Integrity; Grammar; Resource Development/Citation; Clarity/Formality; Development of a Thesis and Writing of a Thesis Statement; Organization and Outlining; Critical Thinking/Analysis/Reasoning; and Development of a Conclusion.
Outcomes:
This course will provide a review of basic writing skills as well help students develop analytical and communication skills that are critical to scholarly writing in the multidisciplinary field of bioethics
BEHL 491 Special Topics (1-3 Credit Hours)
Provides an opportunity to introduce new courses.

BEHL 492 Master's Research - Capstone (3 Credit Hours)
The capstone course is the final course which provides an opportunity for the student to develop a paper of publishable quality.

BEHL 493 Independent Study (3 Credit Hours)
This course will provide students with a broad introduction to the history and role of mission leadership in Catholic health care and will introduce students to the five main competency areas: theology/ministry, spirituality, ethics, organizational management/finance, and leadership. Guest faculty lecturers will share experiences working in mission integration in Catholic health care.

Outcomes:
Students will be introduced to the CHA "Competencies for Health Care Mission Leadership" in order to understand the scope of the position and how the various competency areas interact.

BEHL 500 Introduction to Healthcare Mission Leadership (3 Credit Hours)
This course will provide students with a broad introduction to the history and role of mission leadership in Catholic health care and will introduce students to the five main competency areas: theology/ministry, spirituality, ethics, organizational management/finance, and leadership. Guest faculty lecturers will share experiences working in mission integration in Catholic health care.

Outcomes:
Students will be introduced to the CHA "Competencies for Health Care Mission Leadership" in order to understand the scope of the position and how the various competency areas interact.

BEHL 501 Church and Mission (3 Credit Hours)
In the 21st century the Church is a concept best understood within a global context. We will explore the biblical and apostolic concept of Church progressing through Vatican II. We will also examine the four marks of the Church from both historical and contemporary perspectives.

Course equivalencies: X-IPS 402/ BEHL 501

Outcomes:
Articulate a vision of Church, evaluate and critique different ecclesiologies, and understand the development and structure of the Church from biblical times through Vatican II and contemporary times.

BEHL 502 Christian Doctrine (3 Credit Hours)
This course surveys the historical evolution of Christian doctrine and its theological interpretations from the early church through the 21st century. It assists students in understanding how theological doctrines apply to contemporary ministry contexts, particularly the work of Catholic health care. The course explores the early Christological controversies, the Trinity, Grace, liberationist theologies, and the role of dialogue as a fundamental feature of the development of doctrine.

Outcomes:
Students will understand theological doctrine and apply to contemporary ministry contexts in Catholic health care.

BEHL 503 Foundations of Christian Spirituality (3 Credit Hours)
Christian spirituality (the 'lived experience of Christian faith') is a separate but partnered academic field with theology today. Key issues are: defining 'spirituality,' methods in the field, spirituality vs. institutional religion, Jesus Christ (christology), major figures and movements in Christian spirituality's 2000 year history, and classical and contemporary themes.

Course equivalencies: X-IPS 545 / BEHL 503

Outcomes:
Facilitate defining spirituality and Christian spirituality, and an informed understanding of the person Jesus Christ, the history of Christian spirituality, and the relationship of spirituality to theology and institutional religion.
BEHL 504 Spiritual Paths in World Religions (3 Credit Hours)
This course explores the spirituality, theology, and practice of the major religious traditions. You will encounter other faith traditions by entering into their sacred prayer and worship experiences and learning from practitioners of that tradition how they encounter the sacred in their own lives.

Course equivalencies: X -IPS 403/BEHL 504

Outcomes:
- Recognize the vast complexity of every religious tradition, resisting the urge to oversimplify; Engage those who practice other traditions in conversation; Experience the spiritual practice of other religious traditions

BEHL 505 Advanced Concepts in Health Systems Management (3 Credit Hours)
The course is structured around a framework that links strategic management with health care outcomes for today and tomorrow. Areas covered include: leadership, team building, planning, customers, markets, information and analysis, communication skills, conflict resolution, resource management, budgeting and organizational performance.

Course equivalencies: X-CMAN 468/BEHL 505/IPS 657

Outcomes:
- Analyze major strategic management processes, describe how evidence-research practice can be applied in health systems management, and integrate a framework for strategic management with the key concepts of outcomes-based performance management

BEHL 506 Fiscal Management for Health Care Organizations (3 Credit Hours)
The course explores the relationship between the national economic environment and the financial context for current models of health care delivery. A variety of fiscal concepts and techniques such as cost accounting, cost behavior, budgeting, cost benefit/cost effectiveness analysis, cost-volume-profit analysis, cost variance analysis, and performance budgeting are explored.

Course equivalencies: X-IPS 658/CMAN 533/BEHL 506

Outcomes:
- Students will develop a framework for understanding key issues in health care financial management; Students will develop a quantitative approach to decision making in health care administration through application of concepts

BEHL 510 Integrated Doctoral Seminar in Ethics, Theology, and Healthcare (3 Credit Hours)
The Integrated Seminars in Ethics, Theology and Healthcare (ISETH) are the core of the Doctorate in Healthcare Mission Leadership (D.HMCL) degree program. Students in the DHCLM program are required to complete three of these seminars, which will be offered every Fall and Spring term with variable topics, as part of their degree program. These courses will be primarily theoretical and methodological in focus, rather than practical.

Outcomes:
- This course is designed to build on and integrate students’ prior graduate coursework in theology and bioethics with their ongoing work in Catholic healthcare

BEHL 511 Mission, Leadership, and Spiritual Formation Seminar (3 Credit Hours)
This course explores the theology, traditions, and current practices foundational for understanding and achieving formation as an essential offering of Catholic health care ministries. By examining a Face to Face Online Hybrid (greater than 75% online) Blended (30%-70% online) variety of methods and models of formation programs of Catholic healthcare in the United States, students will cultivate personal practices that enhance their ability to design and operationalize experiences for persons in various roles within the ministries they serve - from new associate orientation to senior leadership.

Outcomes:
- Gain an understanding and practical ability to ensure the programs, resources, and encounters they design and facilitate are grounded in tradition of Catholic ministry, inviting to diverse participant populations, and support the achievement of specified outcomes; In so doing, understand and develop skills necessary to implement integrative, professional, and valued programs of formation

BEHL 512 Canon Law, Sponsorship, and Church Relations (3 Credit Hours)
This two-month course explores the theology, traditions, and practical applications of canon law in the context of Catholic health care. The course will provide an overview of canon law, the emerging theology of sponsorship and ministerial juridic persons, and review a variety of models of church relations current in contemporary Catholic health care.

Outcomes:
- Students will gain fluency in canon law, gain knowledge of the particular canons in Catholic health care, and develop a deeper understanding of sponsorship in order to understand the specific sponsorship model applicable to their own healthcare context

Biomedical Sciences (BMSC)

BMSC 402 Statistical Methods for Biomedical Science (2-3 Credit Hours)
This course covers a broad array of statistical methods for the biological and medical sciences. Topics include descriptive statistics, non-parametric methods, categorical data analysis, and regression methods for normal, non-normal, and repeated measures data. The course focuses on the analysis of real datasets using RStudio, although no previous programming experience is assumed.

Course equivalencies: CRME420/ BMSC402/MPBH404

BMSC 405 Ethics in Biomedical Sciences (1 Credit Hour)
This is an interactive seminar course where students discuss and debate ethics in biomedical sciences to foster integrity, professional character, and ethical problem solving skills.

BMSC 406 Special Topics (1-3 Credit Hours)
This course covers a specific topic in biomedical sciences. The topics can vary among different special topics courses.

BMSC 410 Biochemistry and Molecular Biology (4 Credit Hours)
This course will give students a broad understanding of the synthesis and functions of the major macromolecules that comprise a cell, and the biochemical mechanisms by which these molecules interact to contribute to cellular function.

BMSC 412 Cell Biology (4 Credit Hours)
This course will provide students with knowledge of the structure and function of cells, including the experimental foundations of cell and molecular biology.
BMSC 414 Systems Biology (3 Credit Hours)
This course will provide first year graduate students with an introduction to human physiology. Emphasis is placed on the major organ systems including the nervous, cardiovascular, pulmonary, renal, gastrointestinal and endocrine systems. Basic physiology of blood, skin and bone, as well as introductory concepts in immunology and pharmacology are also covered.

BMSC 416 Methods Biomedical Science (1 Credit Hour)
This course will familiarize first year graduate students with various methods that are used in contemporary biomedical research. It will introduce methods relevant to molecular biology, tissue culture, transgenic model systems, imaging, biochemistry, bioinformatics, electrophysiology, and immunology.

BMSC 418 Presentation skills (1 Credit Hour)
Scientists must communicate their work in numerous venues, from giving oral presentations in seminars and conferences to writing papers and grant proposals. This course is designed to train students in the design and delivery of effective oral presentations, a skill that can be readily adapted to serve as a starting point for written communications. Identify elements of an effective oral presentation 2. Deliver an effective oral presentation 3. Judge the effectiveness of oral presentations.

Course equivalencies: IDIM418/BMSC418
Outcomes:
1

BMSC 499 Research (2 Credit Hours)
Pre-requisites: First year PhD students will register for one research rotation in the Fall semester (2 credit hours), and two research rotations in the Spring semester (3 credit hours)
Research rotation course for first year students in the Integrated Program in Biomedical Sciences.
Outcomes:
Research course will provide laboratory experience during the first year of study, expected to culminate in the selection of a dissertation research laboratory and mentor at the end of the first year

BMSC 600 Dissertation Supervision (0 Credit Hours)
Following completion of the required 48 credit hours in the first 2 years, IPBS PhD students maintain registration via BMSC 600.
Course equivalencies: BMSC600/MIIM600/PIOL600
Outcomes:
IPBS PhD students will complete their degree work while registered for BMSC 600

Clinical and Applied Mass Spectrometry (CAMS)

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, 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

Integrative Cell Biology (ICB)

ICB 401 Gross Anatomy (6 Credit Hours)
The student develops a knowledge and understanding of the basic concepts and facts of human gross anatomy as it relates to function and clinical problems. Lectures, clinical case-based and problem-based learning, computer-aided instructional materials, and cadaver dissection serve as guides to laboratory study.

ICB 403 Histology (3 Credit Hours)
The course is designed to provide the student with a basic knowledge and understanding of the structure and function of the human body at the light and electron microscopic level. The interdependence between structure and function in the different tissues and organs of the body is emphasized. Clinical and research application of the course material are also stressed.

ICB 411 Advanced Gross Anatomy (2 Credit Hours)
The study of the gross structure of the human body at an advanced level presented at conference sessions. Registrants for this course may include graduate students, advanced medical students, as well as those who hold the M.D. degree and are concurrently registered for advanced work in one of the clinical departments.
ICB 445 Scientific Literature: Review & Critique (1 Credit Hour)
Students are taught critical evaluation of scientific literature, hypothesis testing and presentations. This course involves attendance at scientific presentations by students and outside speakers and a journal club component. Both staff and students participate and the class is only offered during the fall semester. This course alternates with Review and Seminar 446.

ICB 446 Review Seminar (1 Credit Hour)
The student participates in a series of seminars and journal clubs that provide a forum for intensive review of scientific topics. Research progress reports of the students is incorporated into this course as a part of the scientific presentation. This course alternates with the Scientific Literature Course 445 and is only offered during the spring semester.

ICB 449 Research (1-8 Credit Hours)
Independent research for thesis or dissertation under the supervision of an appointed faculty adviser. Credit varies upon assigned effort and time spent in the laboratory. Requires a written report.

ICB 462 Teaching of Anatomy I (2 Credit Hours)
A practical experience in the teaching of Gross Anatomy to graduate and medical students. Students assist in the planning, preparation, and teaching of laboratory sessions. The course allows students to place the experience of teaching gross anatomy on their transcripts as a graded course indicating to future employers that they have gained teaching experience.

ICB 463 Teaching Anatomy II (2 Credit Hours)
A practical experience in the teaching of histology to graduate and medical students. Students assist in the planning, preparation and teaching of laboratory sessions. The course allows students to place the experience of teaching histology on their transcripts as a graded course indicating to future employers that they have gained teaching experience.

ICB 501 Special Topics in Anatomy (1-2 Credit Hours)
Occasionally specific faculty members may offer a specialized seminar course. The purpose of such courses is to further graduate student’s knowledge in a specialized current scientific research area. The graduate students explore in detail one or more areas of special interest through seminars, conferences, library and laboratory work.

ICB 595 Thesis Supervision (0 Credit Hours)
Supervised research and writing leading to the completion of the masters of science thesis and degree.

ICB 600 Dissertation Supervision (0 Credit Hours)
Supervised research and writing leading to the completion of the Ph.D. dissertation and degree.

Microbiology and Immunology (MIIM)

MIIM 402 Microbes & Hosts (3 Credit Hours)
Pre-requisites: Cell Biology BMSC 412, and Molecular Biochemistry BMSC 410 or permission from the instructor
Microbes & Hosts conveys important concepts in bacteriology, virology and immunology as well as the interactions of microbes with host organisms. Through a combination of didactic lectures and group discussions, students will come to appreciate fundamental processes which influence microbe-host interactions.

Outcomes:
Students will have a strong understanding of basic principles of microbiology, virology and immunology as well as an understanding of key concepts related to microbe-host interactions.

MIIM 411 Basic Molecular Microbiology (2-3 Credit Hours)
This course is an introduction to fundamental concepts in microbiology

Outcomes:
Students will be able to demonstrate an understanding of the morphology, growth, division, development, molecular biology, genetics and physiology of microorganisms

MIIM 413 Basic Concepts of Immunology (2 Credit Hours)
This course is an introduction to the concepts of host immunity and defense.

Outcomes:
Students will be able to understand the fundamental principles of immunobiology, immunochemistry and immunogenetics, host immunity and defense, and the basic concepts of normal host defense versus the untoward responses (hypersensitivity) and their consequences

MIIM 414 Virology (3 Credit Hours)
This is a survey course that examines animal viruses and their interactions with host cells.

Course equivalencies: XMBIO414/MIIM414

Outcomes:
Students will be able to demonstrate an understanding of viral structure and multiplication, and molecular interactions of important animal viruses with their host cells

MIIM 415 Medical Immunology (2 Credit Hours)
Pre-requisites: General Biology and/or Cell Biology Course is open to all Integrated Program in Biomedical Sciences PhD and MS students, graduate Nursing students, medical students, and advanced undergraduate students

The medical immunology course provides an in depth description of the components of the innate and adaptive immune system and how they interact to protect humans against infectious microorganisms. The course will have two 3 hour sessions per week for 8 weeks as well as 2 written exams.

Outcomes:
Be able to describe the development and mechanism(s) of activation of the innate and adaptive immune systems, their regulation and outcomes of their inability to do so

MIIM 420 Methods & Techniques in Microbiology Research (1 Credit Hour)
This course is an introduction to the theory of techniques used for research in microbiology and immunology.

Outcomes:
Students will be able to demonstrate competency with various research techniques including spectrophotometry, centrifugation, chromatography, photography, as well as other methods necessary for the study of microbiology, immunology or virology

MIIM 431 The Molecular Biology of Viruses (3 Credit Hours)
Pre-requisites: Include undergraduate or graduate-level courses in cell biology and biochemistry, graduate course 402 Microbes and Hosts, and / or prior approval from the course director(s)

The course will cover molecular biology and biochemistry of virus infections. Current understanding of virus-cell entry, replication, and assembly will be prominent themes. Course will include lectures on viral evolution, ecology, pathogenesis and viral immunology. The interactive course will include lectures, review of current virology literature, and student-led presentations.

Course equivalencies: MBI0431/MIIM431

Outcomes:
Detailed understanding of virology; be able to integrate concepts in this field with chemistry and health science; comprehend and appreciate current literature; be prepared for lab studies
MIIM 441 Immunology-Imunochemistry (3 Credit Hours)
This is an advanced immunology course that emphasizes structural concepts in immunology. Review and discussion of current literature exemplifies concepts presented in lecture.

Outcomes:
Students will demonstrate an understanding of the chemical definition of antigens, immunogens, structural concepts in immunology, immunoglobulin structure, structure of antigens and their interactions, and recognition of antigen by T-cells and B-cells

MIIM 442 Cell & Molecular Immunology (3 Credit Hours)
This is an advanced immunology course that examines the cellular and molecular basis of the immune response.

Outcomes:
Students will be able to demonstrate an understanding of the cellular and molecular basis of the immune response, as well as the cellular cooperation essential to the nature of immunology

MIIM 443 Molecular B-Cell Immunology (4 Credit Hours)
This is an advanced molecular immunology course with emphasis on proteins, genes and molecular interactions within the B-lymphocyte compartment of the immune system. Course includes critical evaluation of recent literature.

Outcomes:
Students will demonstrate an understanding of proteins, genes and molecular interactions within the B-lymphocyte compartment of the immune system

MIIM 461 Microbiological Cytology & Ultrastructure (3 Credit Hours)
This is an advanced course that presents the principles and application of light and electron microscopes for the study of cell structure and function.

Outcomes:
Students will demonstrate an understanding of the principles of light and electron microscopes and their use as tools in cellular and molecular biology

MIIM 471 Molecular Microbial Genetics (4 Credit Hours)
This course introduces advanced students to the importance of genetics to a wide range of biological problems.

Outcomes:
Students will demonstrate an ability to read, think, write, and speak critically about various genetic approaches used to identify essential genes, mutagenesis and recombination, transcription, development, symbiosis, and pathogenesis

MIIM 490 Molecular Biology of Oncogenesis (2 Credit Hours)
This course is an advanced course that provides a detailed analysis of molecular events that result in the tumorigenic transformation of eukaryotic cells.

Outcomes:
Students will demonstrate an understanding of oncogenesis by DNA and RNA tumor viruses, the role of oncogenesis and their relationship to normal genes, hormonal effects, and chromosomal abnormalities

MIIM 492 Research (1-9 Credit Hours)
Independent research for thesis or dissertation under the supervision of a faculty research advisor. Credit varies based upon assigned effort and time spent in the laboratory. Students receive a letter grade from their research advisor.

MIIM 501 Seminar (0 Credit Hours)
This course provides opportunities for students to hear about cutting-edge research being conducted nationally and internationally.

Outcomes:
Students will be able to demonstrate a general awareness of current research in the area of microbiology, immunology and virology

MIIM 502 Special Topics (1-4 Credit Hours)
This course is covers a specific topic in microbiology, immunology or virology.

Outcomes:
Students will be able to articulate a general understanding of the selected topic

MIIM 503 Current Literature (1 Credit Hour)
This is a paper-driven course in which papers of current interest are read and discussed.

Outcomes:
Students will demonstrate an ability to identify, critically analyze and articulate key concepts of scientific papers

MIIM 595 Thesis Supervision (0 Credit Hours)
This course allows the student to pursue a research topic under the mentorship of a faculty advisor.

Outcomes:
Students will contribute to the existing body of scientific knowledge and/or methodology in their thesis area; They will defend their results to their committee members

MIIM 600 Dissertation Supervision (0 Credit Hours)
This course allows the student to pursue a research topic under the mentorship of a faculty advisor. They will defend their results in a public forum.

Course equivalencies: BMSC600/MIIM600/PIOL600

Outcomes:
Students will add new knowledge to the existing body of scientific knowledge in their dissertation area

Neuroscience (NRSC)

NRSC 410 Cellular & Molecular Neurobiology (3 Credit Hours)
This course will review current knowledge of the morphological, biophysical and biochemical properties of neurons. Fundamental neuronal network processes such as stimulus transduction, neuronal plasticity, information processing, and learning and memory will be reviewed.

Outcomes:
An advanced knowledge of the biophysical and biochemical properties of nerve cells and fundamental aspects of more global central nervous system function

NRSC 415 Neurochemistry (3 Credit Hours)
This course is a team-taught neurochemistry course that integrates basic biochemical mechanisms of neurotransmitter synthesis, storage, reuptake, and inactivation with applied correlates to central and peripheral nervous system neurodegenerative disorders. Organic chemistry and neurobiology/neurophysiology are required prerequisite courses. Emphasis is placed on student participation including a student-held lecture series covering a contemporary neurochemical topic of their choosing.

Interdisciplinary Option: Neuroscience
NRSC 421 Neuroscience Teaching (1 Credit Hour)
This course consists in serving as a Teaching Assistant in the medical Neuroscience course labs and proctoring the medical neuroscience course exams. It also includes a weekly pre-lab meeting in which the material for that week’s lab is discussed.

Outcomes:
Experience in teaching neuroanatomy for Neuroscience Graduate Program students

NRSC 422 Behavioral Neuroscience (2 Credit Hours)
This course discusses the brain’s role in sensory perception, higher perceptual functions, attention, learning and memory, executive function, and emotion. It consists of weekly lectures given by the professor or by one or two students.

Outcomes:
An understanding of higher brain function and experience giving presentations

NRSC 423 Special Topics in Neuroscience (3 Credit Hours)
Restricted to Graduate level students. This course explores a wide spectrum of neuroscience-related topics, and the subject matter will vary with each offering.

Outcomes:
Measures include exam performance, in-class participation, and student presentation

NRSC 499 Research (1–9 Credit Hours)
Independent research for thesis or dissertation under the supervision of a faculty research advisor. Credit varies based upon assigned effort and time spent in the laboratory. Students receive a letter grade from their research advisor.

NRSC 502 Neuroscience Journal Club (1 Credit Hour)
Pre-requisites: Must be member of the Neuroscience Graduate Program
One hour weekly course during which all students in the Neuroscience Graduate Program meet to discuss and critically evaluate recent, high impact journal articles covering varied neuroscience topics under the direction of two faculty mentors with neuroscience expertise.

Outcomes:
Students advance their knowledge of new neuroscience concepts and methods, gain experience in presenting in front of a group, and gain confidence in their abilities to critically evaluate experimental design and statistical methods

NRSC 503 Neuroscience Seminar (1 Credit Hour)
In both the fall and spring this course includes monthly Neuroscience seminar presentations by internal and external speakers. In the fall, the course also includes monthly journal club presentations by the graduate students: in the spring the course also includes weekly research progress reports by the graduate students.

Outcomes:
A broad overview of current topics in the field and experience giving research presentations

NRSC 595 Thesis Supervision (0 Credit Hours)
Supervised research and writing leading to the completion of the masters of science thesis and degree.

NRSC 600 Dissertation Supervision (0 Credit Hours)
Supervised research and writing leading to the completion of the Ph.D. dissertation and degree.

Pharmacology (PHAR)

PHAR 405 Pharmacology Journal Club (1 Credit Hour)
This course involves students in reading and presenting the scientific literature in journal club format with the goals of learning to, i) evaluate the pharmacological literature and voice a critique in a constructive manner; ii) present such literature in a peer-context, and iii) assimilate information presented by other speakers and formulate, ask, and discuss around relevant appropriate questions.

PHAR 406 Special Problems in Pharmacology (1-4 Credit Hours)
This course covers a specific topic in pharmacological or biomedical sciences. The topics can vary among different special topics courses.

PHAR 407 Fundamentals of Drug Discovery and Development (3 Credit Hours)
This course introduces the process of drug discovery, and students will explore the theoretical and practical aspects of the entire process from concept to clinical trials. Topics include selection, design and use of disease models, current methods and strategies of drug target identification, lead molecule identification, the clinical trial process and pre- and post-market safety.

Outcomes:
Upon completion of this course, the students will have sufficient understanding of the drug discovery process to: 1) Discuss the methods and strategies used to identify potential drug targets; 2) Describe approaches used to screen for lead molecules; 3) Articulate the general FDA regulatory requirements encountered in bringing a new drug to market; 4) Identify requirements for pre-clinical assessment of potential compounds; 5) Define and describe the steps of the clinical trials process; and 6) Articulate and discuss ethical aspects in drug development, including, but not limited to, animal use, clinical trials, intellectual property and research design and integrity.

PHAR 408 Molecular Basis of Disease and Therapeutics (3 Credit Hours)
The course focus is on understanding contemporary research in the pathophysiology of major human diseases and in the development of respective therapeutic treatment strategies. Emphasis will be on cutting edge studies in molecular medicine, including topics in cardiology, endocrinology, oncology, inflammatory diseases and in the neurosciences. There are no prerequisites, but students should have a solid understanding of cell and molecular biology, biochemistry and systems physiology.

Outcomes:
Understand contemporary research strategies applicable to investigating the molecular basis of disease and therapeutics and develop critical thinking and writing skills in hypothesis testing, experimental design and data analyses

PHAR 409 Principles of Pharmacology (3 Credit Hours)
This course introduces students to the fundamental principles of pharmacology and the clinical use of the major classes of drugs currently used with a focus upon fundamental concepts. Topics include drugs and their receptors, molecular aspects of drug targets and drug action, pharmacodynamics and the quantitative aspects of drug-receptor interactions, pharmacokinetic properties of drugs influencing drug distribution and drug dosing, drug metabolism and the effects of genetics on drug action, mechanisms of drug toxicity, and scientific approaches to the discovery of new drugs. Finally, the pharmacology and clinical uses of the major classes of drugs, including drugs used to treat diseases of various systems including cardiovascular, central nervous system, endocrine/reproductive systems, and cancer are covered.
This course is open to all Ph.D., M.D./Ph.D., and M.S. students. Students will gain a theoretical and practical understanding of how extracellular signals are transduced through receptors into metabolic events. It is designed for second year PhD students who have completed the Biomedical Sciences core curriculum. The format is one lecture followed by one research paper discussion for each topic. Students will also gain in-depth knowledge of the signal transduction topics covered in the course.

**Outcomes:**
Students will be able to interpret data and design experiments examining signal transduction pathways.

**PHAR 415 Current Topics in Pharmacology and Epidemiology of Disease (2 Credit Hours)**
This advanced graduate level course will cover an up-to-date overview of topics directly relevant to pharmacovigilance, pharmacoepidemiology, and the factors that play a role in success or failure of approved therapeutic agents.

**Outcomes:**
Students who complete this course will gain knowledge of major epidemiology concepts and statistical principles used in epidemiology and pharmacovigilance.

**PHAR 420 Pharmacovigilance: A Practical Approach (4 Credit Hours)**
This advanced graduate level course will provide an up-to-date and in-depth understanding of pharmacovigilance in the context of modern pharmaceutical drug development and pharmacology. Pharmacovigilance is the pharmacological science relating to the detection, collection, assessment, monitoring, and prevention of adverse effects associated with pharmaceutical products. Enrollment Condition: Drug Discovery (PHAR 407), recommended but not required. Students will be able to identify and describe the regulatory environment and product safety as it pertains to the collection, assessment, reporting and analysis of adverse events.

**Outcomes:**
Upon completion of this course, students will demonstrate an understanding of pharmacovigilance and patient safety.

**PHAR 453 The Teaching of Pharmacology (1 Credit Hour)**
This course teaches the practice and pedagogy of graduate level teaching. Students work under supervision to prepare and present a didactic lecture which is reviewed by faculty and students.

**PHAR 499 Research (1-12 Credit Hours)**
Independent research for thesis or dissertation under the supervision of a faculty research advisor. Credit varies based upon assigned effort and time spent in the laboratory. Students receive a letter grade from their research advisor.

**PHAR 595 Thesis Supervision (0 Credit Hours)**
Supervised research and writing leading to the completion of the masters of science thesis and degree.

**PHAR 600 Dissertation Supervision (0 Credit Hours)**
Supervised research and writing leading to the completion of the Ph.D. dissertation and degree.