Medical Biophysics
UNIVERSITY OF TORONTO

MEDICAL BIOPHYSICS
COURSE MODULES
2022 – 2023

Note*: This document was last updated on September 15, 2022. Some information may have been altered since that time. To download the most up-to-date version, please visit:*
https://medbio.utoronto.ca/handbook-and-forms

Special Message from the Department

Ontario's response to the COVID-19 pandemic continues to evolve. Changes may occur as the province and its municipalities adjust to new data about the virus. In these circumstances, please be advised that the manner of delivery of courses, co-curricular opportunities, programs, and services is subject to change, in accordance with university policies. The University thanks its students, faculty, and staff for their flexibility during these challenging times as we work together to maintain the standards of excellence that are the hallmark of the University.

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Course module enrolment

To enroll, course modules must be requested by students on ACORN/ROSI. Instructions are available at https://medbio.utoronto.ca/course-registration. Students can only add a course module if no more than 15% of the course has been completed. Students who do not register (pay or defer fees) by the deadline will be removed from their course registration. Courses such as RST9999Y and the seminar course, MBP1015Y are preloaded and requests are not necessary. Students should check ACORN/ROSI to make sure they are enrolled in these two courses.

- If students encounter difficulty when enrolling in their courses, they should contact either Donna (uptown students) or Annette (downtown students).

Course module availability

All biology stream modules will be offered in alternate years. A core set of physics stream modules is offered every year while more specialized topics will be offered in alternate years or based on student and faculty response to the new curriculum. Course modules schedules can be reviewed on the MBP calendar at https://medbio.utoronto.ca/mbp-calendar.

Withdrawing from a course module

Students can withdraw from a course module up until the end of the 3rd class or as long as no more than 50% of the module has been completed. While many instructors and programs consider it best practice to provide students with an interim evaluation of their performance in the course prior to the drop date, this is not a requirement for graduate courses (as per the University Assessment and Grading Practices Policy 2012). To request withdrawal from a module, please email the Coordinator of the module and cc Chau Dang and withdraw in ACORN. If students are unable to withdraw in ACORN, they must complete the Drop Course form and email it to Chau Dang.

Policy for students receiving a failing grade in a course module

In the case where a student receives a failing grade in a module (less than 70%), the failing grade will appear on the student's transcript. If the module is one of the required modules MBP1200H or MBP1201H, the student will need to retake the module the following year. A passing grade is required for a module to count toward the graduation requirements.

Courses offered in other Departments

Graduate students at the University of Toronto can take graduate courses offered in any department, subject to availability and approval of their home department; the latter is given by the MBP graduate coordinators (Dr. Greg Stanisz or Dr. Lothar Lilge) on a case-by-case basis with approval of the student's supervisor and the course coordinator. Please provide Annette (Downtown Students) or Donna (Uptown Students) with a copy of the required approvals. If the student misses the deadline for course registration online, they will need to fill out an Add/Drop Course form: https://www.sgs.utoronto.ca/wp-content/uploads/sites/253/2019/06/AddDropCourses.pdf

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Some examples of courses that may be of interest to MBP graduate students are listed below.

1. *IMM1431H – Immunotherapy*
2. *JNR1444Y – Fundamentals of Neuroscience: Cellular and Molecular*
3. *JEB1365H – Ultrasound: Theory and Applications in Biology and Medicine*
4. *BME1460H – Quantitative Fluorescence Microscopy: Theory and Application to Live Cell Imaging*
5. *JYG1555H – Advanced Topics: Cellular and Molecular Neurobiology*
6. *PSL1026H – Advanced Topics: Experimental Cell Physiology*
7. *CSC2515H – Introduction to Machine Learning*
8. *PSY5110H – Advanced Topics in Behavioural Neuroscience: Imaging Techniques in Preclinical Research*
9. *MSC1006H - Neuroanatomy – Introduction to Anatomical Organization of the Brain*
10. *PSY4706HS - Human Brain Anatomy*
11. *MSC1087H - Neuroimaging Methods using Magnetic Resonance Imaging*
12. *STA2005H - Applied multivariate analysis*
13. *STA4273H – Large Scale Machine Learning*
14. *MBP1023H - Clinical Radiation Physics and Dosimetry*

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COURSE MODULES
2022 – 2023

Course modules schedules can also be reviewed on the MBP calendar at https://medbio.utoronto.ca/mbp-calendar

Mandatory Modules

MBP 1201H - Introductory Biostatistics (0.25 credits)	Sept 9 – Nov 1
MBP 1200H - Scientific Exposition and Ethics (0.25 credits)	Sept 14 – Nov 23

BIOLOGY	DATES
MBP 1303H - Cell Signaling & Metabolism (0.25 credits)	Sept 22 – Oct 27
BCH 2138H – Advanced Electron Microscopy (0.25 credits)	Oct 4 – Nov 8
MBP 1305H - Experimental Models for Cancer Research (0.25 credits)	Nov 3 – Dec 15
MBP 1304H - Predictive Oncology & Therapeutics (0.25 credits)	Mar 6 – Apr 17
MBP 1300H - Quantitative Cancer Genomics (0.25 credits)	Sept 15 – Oct 27
MBP 1301H - Radiation Oncology: Clinical & Experimental Radiobiology (0.5 Credits)	Apr 24 – Apr 28
MBP 1302H - Structural Biology & Proteomics (0.25 credits)	Mar 2 – Apr 13

PHYSICS	DATES
MBP 1400H - Advanced Magnetic Resonance Imaging (0.25 credits)	Mar 1 – Apr 12
MBP 1404H - Basics of Cellular and Molecular Biology (0.25 credits)	Mar 2 – Apr 13
MBP 1402H - Biological Imaging (0.25 credits)	Mar 6 – Apr 17
MBP 1413H – Biomedical Applications of Artificial Intelligence	Jan 12 – Feb 23
MBP 1403H - Biophysics of Focused Ultrasound (0.25 credits)	Oct 31 – Dec 20
MBP 1023H – Clinical Radiation Physics and Dosimetry (0.5 credits)	Jan 9 – May 8
MBP 1405H - Introduction to Bio-Microscopies (0.25 credits)	Jan 10 – Feb 21
MBP 1406H - Introduction to Biophotonics (0.25 credits)	Feb 3 – Mar 31
MBP 1417H - Introduction to Health Physics (0.25 credits)	Feb 6 – Mar 13
MBP 1407H - Magnetic Resonance Imaging – Overview (0.25 credits)	Oct 31 – Dec 19
MBP 1408H - Medical Device Commercialization Essentials (0.25 credits)	Jan 4 – Apr 13
MBP 1409H - Medical Device Innovation and Entrepreneurship (0.25 credits)	Jan 12– Apr 13
MBP 1410H - Nanotechnology for Medicine (0.25 credits)	Jan 11 – Feb 22
MBP 1411H - Overview of Medical Imaging (0.25 credits)	Sept 14 – Nov 7
MBP 1412H - Ultrasound Overview (0.25 credits)	Jan 9 – Mar 7

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PROJECTED COURSE MODULES* 2023 - 2024			
Mandatory Modules			
MBP 1201H - Introductory Biostatistics			
MBP 1200H - Scientific Exposition and Ethics			
BIOLOGY	**DATES**	**PHYSICS**	**DATES**
BCH 2138H – Advanced Electron Microscopy (0.25 credits)		MBP 1416H - Anatomy & Physiology (0.5 credits)	
MBP 1306H - Cancer Epigenetics (0.25 credits)		MBP 1401H - Advanced Ultrasound (0.25 credits)	
MBP 1307H - Development, Stem Cells & Cancer (0.25 credits)		MBP 1404H - Basics of Cellular and Molecular Biology (0.25 credits)	
MBP 1300H - Quantitative Cancer Genomics (0.25 credits)		MBP 1413H - Biomedical Applications of Artificial Intelligence	
MBP 1308H - Radiation Biology & DNA Repair (0.25 credits)		MBP 1403H - Biophysics of Focused Ultrasound, Thermal Biophysics (0.25 credits)	
MBP 1301H - Radiation Oncology: Clinical & Experimental Radiobiology (0.5 Credits)		MBP 1405H - Introduction to Bio-Microscopies (0.25 credits)	
MBP 1311H - Tumor Microenvironment (0.25 credits)		MBP 1406H - Introduction to Biophotonics (0.25 credits)	
		MBP 1407H - Magnetic Resonance Imaging – Overview (0.25 credits)	
		MBP 1408H - Medical Device Commercialization Essentials (0.25 credits)	
		MBP 1409H - Medical Device Innovation and Entrepreneurship (0.25 credits)	
		MBP 1411H - Overview of Medical Imaging (0.25 credits)	
		MBP 1415H - Radiotherapy Physics (0.25 credits)	
		MBP 1412H - Ultrasound Overview (0.25 credits)	

*Projected course offerings subject to change.

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List of Course Modules 2022 - 2023

Fall 2022

Advanced Electron Microscopy

Biophysics of Focused Ultrasound, Thermal Biophysics

Cell Signalling & Metabolism

Experimental Models for Cancer Research

Introductory Biostatistics

Magnetic Resonance Imaging - Overview

Overview of Medical Imaging

Quantitative Cancer Genomics

Scientific Exposition and Ethics

Winter 2023

Advanced Magnetic Resonance Imaging

Clinical Radiation Physics and Dosimetry

Basics of Cellular & Molecular Biology

Biological Imaging

Biomedical Applications of Artificial Intelligence

Introduction to Biophotonics

Introduction to Bio-Microscopies

Introduction to Health Physics

Medical Device Commercialization Essentials

Medical Device Innovation and Entrepreneurship

Nanotechnology for Medicine

Predictive Oncology & Therapeutics

Radiation Oncology: Clinical & Experimental Radiobiology

Structural Biology & Proteomics

Ultrasound Overview

NOTE: Should there be insufficient enrolment in a module listed above, it will be offered the following year.

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Fall 2022		
Topic	**MBP1403H: Biophysics of Focused Ultrasound, Thermal Biophysics**	
Coordinator	Dr. Meaghan O'Reilly	
Day & Time	Tuesdays, 12:30 – 2:30 pm **First lecture is on Thursday Nov 3 at 1pm, all others are on Tuesdays.	
Location	Sunnybrook, 2075 Bayview Avenue, S615	
Recommended Prerequisites	NONE	
Module Goals	Focused ultrasound can induce both thermal and non-thermal effects in biological tissues. These biophysical interactions form the basis of a range of therapeutic applications in current medical practice and in leading-edge research. The first half of this course will focus on thermal biophysics, drawing examples from focused ultrasound therapy as well as from other thermal modalities, such as radiofrequency and microwave. The physical and biophysical interaction mechanisms between the energy sources and tissue will be emphasized. Fundamentals of thermal dosimetry will be covered, with reference to the relevant tissue properties, the models of energy propagation within tissues, experimental techniques for dosimetry measurements, and the resulting biological effects. In the second half of this course nonthermal bioeffects of focused ultrasound will be examined. The physical mechanisms behind these mechanical effects will be covered, with an emphasis on cavitation and cavitation-mediated effects. Treatment monitoring considerations for non-thermal therapies will be discussed. The current status of thermal medicine and of focused ultrasound therapies will be reviewed using select clinical and pre-clinical examples.	
Evaluation Method	Exam (100%)	
Schedule		
Date	**Instructor**	**Lecture**
****November 3, 1-3pm**	Meaghan O'Reilly	Biology/Rationale/Nomenclature
November 8	Meaghan O'Reilly	Blood Flow/Modelling/Energy Delivery
November 15	Meaghan O'Reilly	Energy Delivery (Cont'd)/Thermometry/Treatment Monitoring
November 22	Meaghan O'Reilly	Non-Thermal Mechanisms of Ultrasound/Bioeffects
November 29	Meaghan O'Reilly	Cavitation/Cavitation Nucleating Agents
December 6	No Class	
December 13	Meaghan O'Reilly	Treatment Monitoring for Non-Thermal Therapies
December 20	Exam	

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Fall 2022		
Topic	**MBP1303H: Cell Signaling & Metabolism**	
Coordinator	Drs. Jane McGlade & Vuk Stambolic	
Day & Time	Thursdays at 9:00 am – 11:00 am *2nd lecture: Friday, September 23, 9 – 11 am	
Location	Online via Zoom	
Recommended Prerequisites	NONE	
Module Goals	This module will cover a spectrum of topics in cell biology and biochemistry, including cell-to-cell communication, sensing of extracellular signals, surface receptors as signaling modalities, second messengers, modular architecture of proteins, post-translational modifications as instructive signals, intracellular signal transduction and signaling pathways, effectors of signaling pathways, protein stability and turnover. The module will also encompass a series of themes in cellular metabolism, including cellular energetics, nutrient transport and utilization, plasticity in metabolic networks, cellular metabolism in disease and the interface between cell signaling and cell metabolism. The use of model systems in the study of signaling and metabolism, as well as methodologies for cell signaling research will be discussed. The students should expect to get an advanced understanding of signaling networks and metabolic pathways and knowledge of means for their interrogation.	
Evaluation Method	Students will be evaluated based on a written summary, analysis and critique of a research article related to one of the topics covered in the module. The course coordinators will provide a list of articles to choose from at least two weeks before the due date.	
Schedule		
Date	**Instructor**	**Lecture**
September 22	Kristin Hope	Dysregulated post-transcriptional control in cancer
***Friday September 23**	Jorge Filmus	Wnt and Hedgehog Signalling
September 29	Mohammad Mazhab-Jafari	Fatty Acid Metabolism in Health and Disease
October 6	Courtney Jones	Metabelomics and Targeting Tumour Metabolism
October 13	Iacovos Michael	microRNA signaling networks in cancer
October 20	Rob Rottapel	Receptor Tyrosine Kinase Signaling
October 27	David Andrews	Regulation of Programmed Cell Death

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Fall 2022		
Topic	**BCH2138H: Advanced Electron Microscopy**	
Coordinator	Dr. John Rubinstein	
Day & Time	Tuesday and Thursday, 10-11am for lectures 1-6 (Oct 4, 6, 11, 13, 18, 20) PGCRL, 686 Bay Street, PB255 Tue Oct 25, 10am-12 Lecture 7, PMCRT, Room 15-710 Tue Nov 1, 10am-12 Presentations 1, PMCRT, Room 15-710 Tue Nov 8, 10am-12 Presentations 2, PMCRT, Room 15-710	
Location	Lectures 1-6: PGCRL, 686 Bay Street, Room PB255 Lecture 7 and presentations: PMCRT, 101 College St, Room 15-710	
Recommended Prerequisites	None	
Module Goals	To give a working understanding of the use of electron cryomicroscopy in modern structural biology	
Evaluation Method	Participation: 20%; Assignment: 30%; Presentation evaluation: 50%	
Schedule		
Date	**Instructor**	**Lecture**
October 4 October 6	John Rubinstein	**Introduction and theoretical background.** Abbe's equation, electron wavelength, elastic and inelastic interactions, interaction cross sections, bright field and dark field optics, depth of field, amplitude contrast and phase contrast. **Instrumental considerations**. High vacuum systems, spatial and temporal coherence, thermionic and field emission electron sources, magnetic lenses, stained and vitrified specimens, electron sensors, Shannon-Nyquist sampling theorem, depth of field, contrast transfer functions.
October 11 October 13	John Rubinstein	**Concepts in classical image analysis, Part 1.** Fourier slice theorem and 3D reconstruction, image alignment and averaging in 2D, cross correlation coefficients, cross correlation functions, cross correlation functions with Fourier transforms, representation of images in high-dimensional spaces, image classification. **Concepts in classical image analysis, Part 2.** Euler angles, representing rotations as matrices, Euler angle determination by random conical tilting, Euler angle determination with the common lines theorem, Euler angle determination by projection matching.
October 18 October 20	John Rubinstein	**Modern inference methods in 3D structure estimation and classification**. Structure determination as an optimization problem, stochastic gradient descent for nonconvex optimization in structure estimation and

		classification, branch and bound methods for high-resolution map refinement **Application of cryoEM to protein structure determination.** State-of-the-art research examples including use of the methods to investigate protein high-resolution structure, protein dynamics, and protein-drug interactions.
October 25	John Rubinstein	**Practical considerations in structure determination and validation:** Beam-induced motion correction, Fourier shell correlation, non-uniform map refinement, three-dimensional variability analysis, construction of atomic models, model-to-map Fourier shell correlation, model validation statistics.
Tuesday November 1 Student Presentations #1 (2 hr)	John Rubinstein	Each student will select a classic paper about cryoEM methods and present it to the other graduate students in the class.
Tuesday November 8 Student Presentations #2 (2 hr)	John Rubinstein	Each student will select a classic paper about cryoEM methods and present it to the other graduate students in the class.

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Fall 2022		
Topic	**MBP1305H: Experimental Models for Cancer Research**	
Coordinator	Drs. Laurie Ailles & Shane Harding	
Day & Time	Thursdays at 9:00 am – 11:00 am	
Location	PMCRT, 101 College Street, Room 4-204	
Recommended Prerequisites	NONE	
Module Goals	We will discuss the various model systems used in cancer research, including in vitro models, mouse models, and others as well as models with a specific focus (e.g. metastasis models). There will be an emphasis on the pros and cons of each and the importance of using the correct model for the specific research question. There will be an introductory lecture, then the students will be assigned papers that exemplify the best (or worst) use of different types of models to present/critique. The course evaluation will be based on presentations and a written assignment.	
Evaluation Method	The course evaluation will be based on presentations and a written assignment.	
Schedule		
Date	**Instructor**	**Lecture**
November 3	Laurie Ailles & Shane Harding	Experimental Models for Cancer Research
November 10	Laurie Ailles & Shane Harding	Student presentations of selected papers
November 17	Laurie Ailles & Shane Harding	Student presentations of selected papers
November 24	Laurie Ailles & Shane Harding	Student presentations of selected papers
December 1	Laurie Ailles & Shane Harding	Student presentations of selected papers
December 8	Laurie Ailles & Shane Harding	Student presentations of selected papers
December 15	Laurie Ailles & Shane Harding	Student presentations of selected papers

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Fall 2022	
Topic	**MBP1201H: Introductory Biostatistics - MANDATORY**
Coordinator	Drs. Angus Lau & Jamie Near
Teaching Assistant	Calder Sheagren
Day & Time	Tuesdays, 10 am – 12 noon, PMH 6-604 Special TA sessions (Python bootcamp): • Fri. Sept. 9, 1 pm – 4 pm, PMH 6-604 • Fri. Sept 23, 1 pm – 4 pm, PMH 6-604 TA office hours for Python Q/A - Thursdays 1:30 – 3:30 pm, PMH 7-605
Location	PMH, 610 University Avenue, Room 6-604
Recommended Prerequisites	Required module – there are no prerequisites. However, students are recommended to obtain working knowledge of the Python programming language. (Online Python resources will be distributed to students in advance of the term so that they can be prepared for the Bootcamp session.)
Module Goals	This course will serve as a rapid introduction to probability and statistical thinking with methods drawn from frequentist as well as Bayesian statistics. Students will gain a thorough understanding of how statistical inference is conducted and will, by the end of the course, be able to critically assess our use of statistics in the search for scientific truths
Evaluation Method	5 assignments (10% each) and final exam (50%)

Schedule

Date	Instructor	Lecture
Fri. September 9	TA	Statistical Analysis in Python Bootcamp
September 13	Jamie Near	Probability and Exploratory Data Analysis
September 20	**No class – Departmental Retreat**	
September 23	TA	Statistical Analysis in Python Bootcamp
September 27	Jamie Near	Hypothesis Testing
October 4	Kamil Uludag	Linear Models
October 11	Jamie Near	Inference and Prediction
October 18	Juri Reimand	Introduction to Non-Parametric Statistics
October 25	Bo Wang	Introduction to Artificial Intelligence in Healthcare
November 1	**Exam**	

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Fall 2022		
Topic	**MBP1407H: Magnetic Resonance Imaging – Overview**	
Coordinator	**Dr. Jean Chen**	
Teaching Assistant	Jaykumar Patel	
Day & Time	Mondays, 12:30 – 2:30 pm	
Location	Via Zoom	
Recommended Prerequisites	A foundation in signals and systems theory and Fourier transforms is required. Students are strongly advised to take the Overview of Medical Imaging module prior to this module.	
Module Goals	Since development of the first hospital-grade systems in the 1980s, magnetic resonance imaging (MRI) continues to make a profound impact on how physicians evaluate soft tissues within the human body. This course provides students with an overview of MRI technology covering the underlying physical principles of signal generation, signal contrast mechanisms, process of image formation, and basic instrumentation. The course is a prerequisite for students who subsequently wish to take Advanced Topics in MRI.	
Evaluation Method	Assignments (10%), Lab (40%) and Final Assignment (50%)	
Schedule		
Date	**Instructor**	**Lecture**
October 31	Kamil Uludag	Basic MR Physics 1
November 7	Brian Nieman	Imaging Physics 1
November 13	TA	Assignment 1 due Tutorial 1
November 14	Kamil Uludag	Topics in MR Imaging
November 21	Brian Nieman	Imaging Physics 2
November 25	TA	Assignment 2 due Tutorial 2
November 28	Jean Chen	MRI Quality, Safety and Laboratory
December 16	**Lab report due**	
December 19	**Final Exam**	

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Fall 2022		
Topic	**MBP1411H: Overview of Medical Imaging**	
Coordinator	Dr. John G. Sled	
Day & Time	Wednesdays, 9:30 – 11:30 am	
Location	Sunnybrook, 2075 Bayview Ave. Room SG22	
Recommended Prerequisites	Students are expected to have a foundation in undergraduate level mathematics including differential and integral calculus, complex numbers, linear algebra, and probability theory. Students entering from an engineering or physics undergraduate program will likely need no additional preparation. Students from another discipline may need additional preparation and should contact the module coordinator well in advance as to whether self-directed reading prior to the module start is recommended.	
Module Goals	This module provides the mathematical preliminaries of medical imaging and introduces concepts of image formation, inverse problems, stochastic processes and instrument performance that are common to many medical imaging modalities. An introduction and historical perspective on the major medical imaging technologies is also presented. This course is a recommended prerequisite for many the imaging modules offered by MBP including those on MRI and ultrasound.	
Evaluation Method	Exam (70%) and lab report (30%)	
Schedule		
Date	**Instructor**	**Lecture**
September 14	Martin Yaffe	Introduction to Medical Imaging: a brief history
September 28	John G. Sled	Linear Systems and Fourier Transform Theory I
October 5	John G. Sled	Linear Systems and Fourier Transform Theory II
October 12	John G. Sled	X-rays and Projections
October 19	John G. Sled	Tomography and Inverse problems
October 26	James Mainprize	X-ray CT lab (may need to be scheduled on multiple days to accommodate the number of lab groups)
November 2	TBD	PET and SPECT imaging + open discussion
November 9	Exam	

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Fall 2022		
Topic	**MBP1300H: Quantitative Cancer Genomics**	
Coordinator	Dr. Trevor Pugh and Dr. Mathieu Lupien	
Day & Time	Thursdays, 1 – 3 pm	
Location	PMCRT, 101 College Street, Room 15-710	
Recommended Prerequisites	Undergraduate molecular biology and genetics	
Module Goals	Each class will consist of a 1-hour student lecture reviewing the day's topic in detail, followed by interactive discussion around a specific paper, case report, or mini-workshop illustrating the application of research findings in a novel way (e.g. clinical application, meta-analysis, new use for old data). The organizing Instructor will provide a list of topics that must be covered by the student in the review portion of the class and moderate discussion during the more open portion.	
Evaluation Method	Each student will be responsible for a Lecture Topic Review to be held in the first hour (35% of their grade) and for a Scientific Manuscript Presentation in the second hour (35% of their grade) of each lecture. All other students are expected to contribute to the Scientific Manuscript Discussion in each lecture (30% of their grade). The class accepts a minimum of 6 and maximum of 14 students. Instructors are to provide the lecture topic and can suggest manuscripts to be discussed in the second hour at least one week prior to the start date. The selected Scientific Manuscript is to be shared with all students at least 3 days before the lecture (usually Monday the week of the class). Lecturers will be available in person or by email to provide an optional review of the student's proposed presentation and discussion plan up to 3 days prior to student's presentation. The instructors are responsible for assigning the student's grade using an evaluation form common across all of the lectures.	
Schedule		
Date	**Instructor**	**Lecture**
September 15	Trevor Pugh & Mathieu Lupien	Course overview and setting expectations.
September 22	Trevor Pugh	Clinical cancer genomics: Approaches to analysis of cancer genomes to guide patient care.
September 29	TBD	TBD
October 6	Federico Gaiti	Non-genetic mechanisms of cancer evolution: A single-cell perspective
October 13	Gregory Schwartz	Deconvolving cancer heterogeneity
October 20	Faiyaz Notta	Cancer cell heterogeneity and plasticity
October 27	Mathieu Lupien	Genome hacking – treating cancer as a disease of the chromatin

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Fall 2022		
Topic	**MBP1200H: Scientific Exposition and Ethics – MANDATORY**	
Coordinator	Drs. David Malkin & Jim Woodgett	
Teaching Assistant	Andrea Tench	
Day & Time	Wednesdays, 1:30 – 3:30 pm	
Location	Princess Margaret Cancer Centre, 610 University Avenue, 6th floor auditorium	
Recommended Prerequisites	NONE	
Module Goals	Scientific exposition, discourse and ethics are fundamental principles to the conduct of responsible basic, translational and clinical research. This course will use a combination of didactic lectures and interactive group discussion to explore key elements of these principles under the broad headings of: 1) Principles of Ethical Conduct and Protection of Research Subjects; 2) Scientific Fraud, Plagiarism and Data Misrepresentation – Flagrant and Unintended; 3) Privacy and Confidentiality in the Genome Era (Data Sharing/Validation/Clinical Translation); 4) Authorship Responsibility in the Spirit of Collaboration and Intellectual Property Protection; and 5) Equity, Diversity and Inclusion in Science. The format of each lecture will be both didactic, with the lecturer discussing fundamental issues and principles relevant to the topic, and interactive with opportunity for open discussion of a foundational aspect of the subject being addressed in the lecture.	
Evaluation Method	End of course exam with a combination of short- and long- answer questions based on information discussed in the lectures, and supplemented with materials provided by the lecturers, and an end-of-course assignment which will involve discussion of a problem-based 'scenario'. The topics for the 'scenarios' will provided by the course co-directors. The 'exam' will count for 50% of the final mark and the in-class problem/discussion session will count for 50%.	
Schedule		
Date	**Instructor**	**Lecture**
September 14	Jim Woodgett	Research Ethics: Responsibilities and Best Practices
September 21	**NO CLASS – MBP Retreat**	
September 28	Ivan Topisirovic	Biomedical Research: Ethos, Logos... and Pathos (on research misconduct)
October 5	**NO CLASS**	
October 12	Beth Stephenson	Principles of Ethical Conduct and Protection of Research Subjects
October 19	Bojana Stefanovic	Equity, Diversity and Inclusion in Science

October 26	David Malkin	Authorship Responsibility in the Spirit of Collaboration and Intellectual Property Protection
November 2	Stephen Scherer	Privacy and Confidentiality in the Genome Era (Data Sharing/Validation/Clinical Translation)
November 9	Jim Whitlock	How do children in Canada (and the rest of the world) access promising new cancer therapies?
November 16	Group Presentations	
November 23	**Exam – Exam Centre Rm. EX 300**	

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Winter 2023		
Topic	**MBP1400H: Advanced Magnetic Resonance Imaging**	
Coordinator	Dr. Charles Cunningham	
Day & Time	Wednesdays, 12:30 – 2:30 pm	
Location	Sunnybrook, 2075 Bayview Ave., Room S615	
Recommended Prerequisites	Overview of Medical Imaging, Magnetic Resonance Imaging – Overview	
Module Goals	To gain an advanced understanding of how MRI works	
Evaluation Method	Assignments only	
Schedule		
Date	**Instructor**	**Lecture**
March 1	Charles Cunningham	Phase encoding, frequency encoding, hybrids, RF pulses
March 8	Christopher Macgowan	Effects of motion, ghosting, motion compensation methods
March 15	Christopher Macgowan	Phase contrast and flow (2D & 4D), non-contrast angio, myocardial tagging, clinical implementation
March 22	Giles Santyr	MRI Contrast Mechanisms, endogenous and exogenous
March 29	Giles Santyr	Paramagnetic, susceptibility-based, CEST contrast, magnetization transfer, hyperpolarized agents
April 5	Philip Beatty	Image reconstruction - non-cartesian sampling and gridding
April 12	Philip Beatty	Multi-channel signal acquisition and image reconstruction

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Winter 2023		
Topic	**MBP1404H: Basics of Cellular & Molecular Biology**	
Coordinator	Drs. Margarete Akens & Dr. Arash Zarrine-Afsar	
Day & Time	Thursdays, 9:00 – 11:00 am	
Location	PMCRT, 101 College Street, Room 4-204	
Recommended Prerequisites	NONE	
Module Goals	This course provides introduction to basic concepts of anatomy, cellular & molecular biology and cell signaling related to cancer formation and progression. Methods for the analysis of genome & proteome will be discussed along with computational image analysis principles. The course will stress breadth of knowledge rather than depth. Participation mark combines attendance and active engagement in the discussions.	
Evaluation Method	75% exam, 25% participation	
Schedule		
Date	**Instructor**	**Lecture**
March 2	M. Akens and A. Zarrine-Afsar	Cell structure & function
March 9	A. Zarrine-Afsar	Methods in molecular biology & proteomics
March 16	M. Akens	Developmental biology & anatomy
March 23	J. Woodgett	Signalling
March 30	C. McIntosh	Computational methods for image analysis
April 6	T. Pugh	Genomics
April 13		

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Winter 2023		
Topic	**MBP1402H: Biological Imaging**	
Coordinator	Drs. Brian Nieman & Chris Macgowan	
Day & Time	Mondays, 10 am – 12 noon	
Location	PMCRT, 101 College Street, Room 15-710	
Recommended Prerequisites	NONE	
Module Goals	The first goal of the module is to develop an understanding of how imaging can be used to probe important questions in biology. A series of lectures will address: (1) knowledge gaps in a recent area of research where imaging proved beneficial; (2) methodological developments required to address those gaps; and (3) how imaging advanced our knowledge of the field. The second goal of the module is to become familiar with grant proposals and application processes. Each lecture will be paired with reading from a funded grant application. Grantsmanship insights, strategies and pitfalls will be discussed. Through the module, students will generate and pitch their own project idea, participate in peer feedback, and craft their own short proposals.	
Evaluation Method	Students will prepare a short grant proposal of their own design related to imaging in biological research. Evaluation will be based on general participation (10%), idea pitches (20%), peer review and evaluation (20%), and a short, written proposal (50%).	
Schedule		
Date	**Instructor**	**Lecture**
March 6	Christopher Macgowan & Brian Nieman	Module Introduction & Lecture 1
March 13	Alex Vitkin	Lecture 2 & Grant Discussion Instruction: Reviewing Grants
March 20	Christopher Macgowan	Lecture 3 & Grant Discussion Instruction: Grant Budgets
March 27	Christopher Macgowan & Brian Nieman	Grant Pitches & Feedback
April 3	Olivier Villemain	Lecture 4 & Grant Discussion Instruction: Chairing Grant Panels
April 10	Christopher Macgowan & Brian Nieman	Peer Review of Grant Proposals
April 17	John Rubinstein	Lecture 5 & Grant Discussion

*Lecturers and scheduling subject to change based on availability.

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Winter 2023		
Topic	**MBP1413H: Biomedical Applications of Artificial Intelligence**	
Coordinator	Drs. Mark Chiew and Maged Goubran	
Day & Time	Thursdays, 10:00 am – 12:00 pm.	
Location	TBC	
Recommended Prerequisites	MBP1201H – Introductory Biostatistics or equivalent. Students should have a good working knowledge of probability, differential and integral calculus. The assignments will require programming in Python. A good understanding of the core syntax and principles of structured programming in Python or another programming language is required.	
Module Goals	This module is a graduate level course in machine learning and artificial intelligence applied to biomedical research. It covers core concepts, machine learning algorithms, and deep learning approaches. Applications in medical imaging, genomics and clinical information are discussed. Students will have an in-depth course project applying these techniques to real-world datasets from their own research.	
Evaluation Method	Assignments (40%) and final project (60%)	
Schedule		
Date	**Instructor**	**Lecture**
January 12	TBD	TBD
January 19	TBD	TBD
January 26	TBD	TBD
February 2	TBD	TBD
February 9	TBD	TBD
February 16	TBD	TBD
February 24	TBD	Project presentations

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Winter 2023	
Topic	**MBP1023H: Clinical Radiation Physics and Dosimetry**
Coordinator	Harry Keller, Jan Seuntjens
Day & Time	Lecture: Mondays 3:30 PM to 5:30 PM Exercise hour: Tuesdays or Wednesdays TBA
Location	TBA
Recommended Prerequisites	Undergraduate physics and mathematics
Module Goals	The course syllabus is in accordance with the syllabus for an advanced radiation physics course as specified in AAPM Task Group 197 "Academic Program Recommendations for Graduate Degrees in Medical Physics".
Evaluation Method	The grade will be composed of the performance in the midterm exam (30%), final exam (50%), and class participation (20%). The class participation mark consists of the mark of a short class presentation and participation in white-board exercises.

Schedule

Date	**Instructor**	**Lecture**
January 9	Harry Keller/Jan Seuntjens	Introduction to Ionizing Radiation (1) Description of Radiation Fields (1)
January 16	Harry Keller/Jan Seuntjens	Introduction to photon Interactions (2)
January 23	Harry Keller/Jan Seuntjens	Photon interactions I
January 30	Harry Keller/Jan Seuntjens	Photon interactions II
February 6	Harry Keller/Jan Seuntjens	Charged Particle Interactions (1) Charged Particle Interactions: elastic scattering, multiple scattering, scattering power (1)
February 13	Harry Keller/Jan Seuntjens	Charged Particle Interactions: Hard Collisions, soft collisions, energy loss and stopping power (unrestricted and restricted), radiative stopping power
February 20		Holiday
February 27	Harry Keller/Jan Seuntjens	Electron Range, Radiation Equilibrium
March 6	Harry Keller/Jan Seuntjens	Midterm Exam
March 13	Harry Keller/Jan Seuntjens	Self-study: Absorbed Dose from radioactive materials, Alpha Decay, Beta Decay
March 20	Harry Keller/Jan Seuntjens	Gamma Decay, CPE External Radiation
March 27	Harry Keller/Jan Seuntjens	Introduction to Dosimetry (1) Cavity Theory I (1)

April 3	Harry Keller/Jan Seuntjens	Cavity Theory II
April 10	Harry Keller/Jan Seuntjens	Cavity Theory III (1) Ionization chambers (1)
April 17	Harry Keller/Jan Seuntjens	Ion Chamber Dosimetry I Photon Beam Calibration I
April 24	Harry Keller/Jan Seuntjens	Ion Chamber Dosimetry II Photon Beam Calibration II, TG-51, Electron Beam Calibration
May 1	Harry Keller/Jan Seuntjens	Review
May 8	Harry Keller/Jan Seuntjens	Final Exam

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Winter 2023		
Topic	**MBP1405H: Introduction to Bio-Microscopies**	
Coordinator	Drs. Brian Wilson, Ralph DaCosta, Mohammad Mazhab-Jafari	
Day & Time	Tuesdays, 9:00 am – 11:00 am	
Location	PMH, 610 University Avenue, Room 7-605	
Recommended Prerequisites	None	
Module Goals	Various forms of microscopy are widely used in biomedical research as well as in clinical medicine. Major classes of microscopy include: A) optical microscopy (wide-field, fluorescence, laser-scanning confocal, Raman, bioluminescence, near-field/scanning-probe, super-resolution, non-linear, light-sheet, intravital), together with a variety of fluorescent and other probes (dyes, fluorescent proteins, small-molecules) and B) electron microscopy, in both transmission and surface-scanning modes. The goal of this Module is to introduce the basic physical principles of the different forms of microscopy and survey the different techniques, instruments and probes used in studying bio-specimens (cells, tissues, biomaterials), illustrating these with examples of biomedical applications. The role of digital techniques and image processing/analysis will be considered.	
Evaluation Method	Written assignment	
Schedule		
Date	**Instructor**	**Lecture**
January 10	Brian Wilson	Introduction and Optical Microscopy-1
January 17	Brian Wilson	Optical Microscopy-2
January 24	Brian Wilson	Optical Microscopy-3
January 31	Ralph DaCosta	Intravital Microscopy
February 7	Mohammad Mazhab-Jafari	Electron Microscopy
February 14	ALL	Discussion/Tutorial
February 21	AOMF (optional)	Hands-On

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Winter 2023		
Topic	**MBP1406H: Introduction to Biophotonics**	
Coordinator	Drs. Alex Vitkin & Lothar Lilge	
Day & Time	Fridays, 10:00 am – 12 noon	
Location	PMCRT, Room 15-710	
Recommended Prerequisites	None	
Module Goals	The use of light in medical diagnostics, therapeutics and biomedical research is increasing, driven by the advent of new light sources, inexpensive imaging detectors, advanced fiber-optic delivery systems, better understanding of light-tissue interactions, and proven research and clinical applications. The course will focus mostly on *in vivo* photonics and initially cover (1) the relevant issues of light propagation in / interaction with turbid media such as tissue. The bulk of the course will focus on (2) particular technical implementations and research / pre-clinical / clinical results in photo-diagnostics (effects of *tissue on light*) and photo-therapeutics (effects of *light on tissue*). Advanced topics such as (3) molecular imaging, nanophotonics, optical clearing and theranostics will also be briefly covered. As such, the course goals include basic competencies in these three [(1)-(3)] areas. For students with limited background in optics and photonics, we will also run a series of tutorials to provide some "light" basics we deem useful for the course. These will be offered prior to the module itself, and will be optional for interested students.	
Evaluation Method	Class participation (25%), and the oral exit exam (75%)	
Schedule		
Date	**Instructor**	**Lecture**
February 3	TBD	TBD
February 10	TBD	TBD
February 17	TBD	TBD
February 24	TBD	TBD
March 3	TBD	TBD
March 10	TBD	TBD
March 17	TBD	TBD

March 24	TBD	TBD
March 31	TBD	TBD

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Winter 2023	
Topic	**MBP1417H: Introduction to Health Physics**
Coordinator	Dr. Jean-Pierre Bissonnette
Day & Time	Mondays, 10:00 am – 12:15 pm
Location	OPG, 700 University Ave., 6th floor
Recommended Prerequisites	At the discretion of the course coordinator.
Module Goals	This module examines how radiation affects public health. Starting from basic physics and biology of radiation interactions with materials and tissues, resultant radiation regulations and policies will be scientifically justified, with selected examples in the Canada/Ontario hospital settings. Effective protection from natural or artificial radiation sources, using time, distance and shielding principles, will be covered. Radiation detectors and dosimetry will be presented. Safety design aspects of radiotherapy vaults, radiology rooms, and radiation research laboratories will be a major focus of the second part of the course. Visits to the UHN Nuclear Medicine labs and radiation therapy treatment vaults will provide practical context for these concepts.
Evaluation Method	Final exam (60% of the final grade) Lab report (40% of the final grade)

Schedule

Date	Instructor	Lecture
February 6	Michelle Nielsen	Introduction and history of radiation protection. Review of Radiation Physics and Radioactivity. Quantification of radiation: physical, dosimetric, biological quantities. Basic physics of radiation protection.
February 13	Michelle Nielsen	Biological effects of radiation. Radiation damage at the cellular and macroscopic levels. Linear, no-threshold theory. Radiation epidemiology and predictions of cancers in populations. Stochastic and non-stochastic effects. Effects on the fetus. Data-driven regulated dose limits.
February 20	Robert Heaton	Physics of radiation detectors, personal dosimetry and monitoring. External exposure and associated calculations. Internal exposure and the MIRD calculation model.
Lab/assignment	Jean-Pierre Bissonnette & Alex Rink	Self-learning assignment, designing and write a radiation shielding calculation and report for a realistic hospital facility.
February 27	David Niven	Radiation protection in hospitals part 2: radiation research laboratory and Nuclear Medicine. Open sources. Environmental dispersion. Laboratory visit: Nuclear Medicine laboratories.

March 6	Jean-Pierre Bissonnette & Ivan Yeung	Process mapping, failure mode and effects analysis, fault tree analysis. The London protocol. Radiation safety consideration in the context of the emerging theranostics paradigm
March 13	Jean-Pierre Bissonnette	Reports for labs & final exam

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Winter 2023	
Topic	**MBP1408H: Medical Device Commercialization Essentials**
Coordinator	Drs. Graham Wright, Brian Courtney, & Ahmed Nasef
Day & Time	Thursdays, 6:00 – 7:00 pm
Location	Online
Recommended Prerequisites	Medical Device Innovation & Entrepreneurship is a co-requisite (must be taken at the same time)
Module Goals	Not all medical device innovations will make it into patient care. Without a compelling, accessible market, a sustainable business model and operating plan, a well-thought-out plan for acquiring and managing intellectual property, and strong regulatory and reimbursement strategies, even the seemingly most important medical innovations are unlikely to be commercialized. The Medical Device Commercialization Essentials course complements the Medical Device Innovation and Entrepreneurship module and provides students with an experiential connection to the process of commercializing novel medical discoveries. The course focuses on systematic examination of issues and factors that directly affect the financial viability and sustainability of a medical device innovation and impact the innovator's ability to successfully commercialize a solution. The delicate and frequently conflicting interplay between intellectual property, regulatory environment, reimbursement mechanisms, business strategy and financial modelling are explored with hands-on exercises and interactive workshops. The module is recommended for students who would like to: (1) catalyze innovation in major medtech companies; (2) build their own medtech start-ups; (3) draw on world-class innovative research conducted in Canadian universities, research institutes and hospitals; and (4) lead translational research projects.
Evaluation Method	In the Medical Device Innovation & Entrepreneurship module, students present a systematic review of significant clinical challenges and propose a strategic assessment of novel medical device solutions that address the gaps in these challenges. In this commercialization module, students are required to incorporate the analysis and critical review of the prospective novel medical device concept from assignment 1 into a high-level report or a business case proposal. Students are to assume that this high-level proposal will be reviewed by a commercialization manager through Sunnybrook's technology transfer office. The commercialization manager will assess the potential of financially supporting the commercialization of this technology and determine whether or not an adequate market opportunity exists to support the development of an innovation. The students should draft the business case proposal within this commercialization context. The business case proposal should include the following sections to demonstrate commercialization potential: technology overview, market opportunity, industry analysis, business model/value proposition, cost and revenue structure, investment requirements, and associated preliminary IP and reimbursement strategies. Grading Scheme: Class participation (10%), Group Report (90%).

Schedule		
Date	**Instructor**	**Lecture**
January 4	TBD	TBD
January 11	TBD	TBD
January 18	TBD	TBD
January 25	TBD	TBD
February 1	TBD	TBD
February 8	TBD	TBD
February 15	TBD	TBD
February 22	TBD	TBD
March 1	TBD	TBD
March 8	TBD	TBD
March 15	TBD	TBD
April 13	**Final Report due**	

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Winter 2023	
Topic	**MBP1409H: Medical Device Innovation and Entrepreneurship**
Coordinator	Drs. Graham Wright, Brian Courtney, and Ahmed Nasef
Day & Time	Thursdays, 4:30 – 5:30 pm
Location	Online
Recommended Prerequisites	NONE
Module Goals	Innovations in Medical technology have led to revolutionary advancements in health care. As new devices and technologies are developed, patients are benefiting from more targeted, less invasive treatments. However, new standard of care technologies won't reach the bedside unless inventors have the skills to bring them to market. The Medical Device Innovation and Entrepreneurship course is an opportunity to explore and navigate the principles underlying the challenges of medical device development. The course is designed to engrain the key mindsets and skill sets that help make successful medtech entrepreneurs. The course addresses the fundamental aspects from developing an idea to commercial success, enabling students to gain knowledge of the role of intellectual property management, regulatory pathways, reimbursement mechanisms, funding models, and business strategy in the successful commercialization of new medical device technologies. The course is delivered using a mix of lectures, guest speakers, team projects, recommended readings and online learning materials. In addition, students get the opportunity to network with local experts and thought leaders in the medtech field. The module is recommended for students who would like to: (1) catalyze innovation in major medtech companies; (2) build their own medtech start-ups; (3) draw on world-class innovative research conducted in Canadian universities, research institutes and hospitals; and (4) lead translational research projects.

Evaluation Method	Teams of students will have the opportunity to examine and analyze medical technologies that address unmet healthcare needs. Students will be required to explore the clinical problem context, assess the clinical need, motivations and influences of all stakeholders, identify and analyze existing solutions and treatment options, and assess market and commercialization potential with the goal of providing a critical review and strategic assessment of the identified technologies. This year's projects will include, but not limited to, any of the following pandemic-related focus areas: (i) optimization of isolation/quarantine, (ii) prevention of transmission and personal protective equipment, and (iii) surge capacity for ventilation and critical care. Students will be evaluated based on: (i) in-class participation; and (ii) a presentation, which will include the following sections: • An assessment of the clinical need & underlying problem leading to the new device. Students are expected to perform medical literature reviews through online sources e.g. PubMed, Harrison's online, etc. • Market analysis including market size, segments, attractiveness, and competitive dynamics • Analysis of the different parties and stakeholders involved in delivering and financing care related to the clinical challenge (e.g. patients, physicians, hospitals, government officials/legislators, MOHLTC, nurse practitioners, etc.) • Analysis of treatment options and innovations available prior to the identified novel device that tried to address the identified clinical challenge. Students are expected to perform a comprehensive review of previous innovations outlining their strengths and weaknesses. • An overview of the medical device concept that has been developed to address the need including associated regulatory & reimbursement considerations. • A critical review of possible areas of improvement for the identified device Students will be evaluated on how well they have taken the lessons taught during the course and applied them. For all evaluations, students are required to demonstrate both that they have the evidence to support their claims as well as that they have added value by extending the analysis and using creativity. Grading Scheme: Class participation (10%), Group Presentation (90%).	
Schedule		
Date	**Instructor**	**Lecture**
January 12	TBD	TBD
January 19	TBD	TBD

January 26	TBD	TBD
February 2	TBD	TBD
February 9	TBD	TBD
February 16	TBD	TBD
February 23	TBD	TBD
March 2	TBD	TBD
March 9	TBD	TBD
March 16	TBD	TBD
March 23	TBD	TBD
March 30	TBD	TBD
April 6	TBD	TBD
April 13	**Exam**	

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Winter 2023		
Topic	**MBP1410H: Nanotechnology for Medicine**	
Coordinator	Dr. Gang Zheng	
Day & Time	Wednesdays, 12:30 – 2:30 pm	
Location	U of T Health Sciences Building, 155 College Street. Rm HS100	
Recommended Prerequisites	NONE	
Module Goals	This course is a critical and timely analysis of the current state of the nanomedicine field, how it has become incorporated in to multiple disciplines, and the factors that must be considered for its future progress and successful clinical implementation. The course will begin with an introduction to nanotechnology, the unique physical properties that define nanoscale materials, and the state of art techniques to study the nanobiointerface. The course will focus on the design considerations for nanoparticles will be considered through a discussion of how they interface with biology, which make them advantageous additions to the toolkit of agents for disease diagnosis and therapy. The course will then progress to sophisticated approaches for nanomedicine applications including mRNA vaccines and gene editing. Finally, the course will conclude by covering challenges and opportunities in translation of nanomedicines to the clinic.	
Evaluation Method	Each student will produce a written report of a topic covered in the course but unrelated to their thesis project plus an oral presentation on the March 1st class. Format: journal mini-review style, max. 5 pages (1.5 space, pt 12 font) with one figure plus references. Evaluation criteria will be heavily weighted on quality of analysis. The grade will be a combination of attendance and participation (10%),written report (70%) and oral presentation (20%).	
Schedule		
Date	**Instructor**	**Lecture**
January 11	Warren Chan	Introduction to Nanomedicine
January 18	Gilbert Walker	Physical Properties Unique to Nanoscale Materials
January 25	Milica Radisic	Nanotechnology in Drug Delivery
February 1	Bowen Li	Lipid Nanoparticles for mRNA vaccines and gene editing
February 8	Raymond Reilly	Nanotechnology in Radiation Medicine
February 15	Gang Zheng	Nanomedicine clinical translation
February 22	**Course Evaluation**	

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Winter 2023		
Topic	**MBP1304H: Predictive Oncology & Therapeutics**	
Coordinator	Drs. Benjamin Haibe-Kains & Federico Gaiti	
Teaching Assistant	Mr. Cory Richman	
Day & Time	Mondays 1:00 pm – 3:00 pm	
Location	PMCRT, 101 College St., 4-204	
Recommended Prerequisites	NONE	
Module Goals	One of the main challenges in precision medicine is the selection of the therapeutic strategy that will benefit the most to each individual patient. With the advent of high-throughput profiling technologies, more and more data can be generated to deeply characterize the molecular state of cancer cells and the phenotypes resulting from drug treatment both in vitro and in vivo. The "Predictive Oncology & Therapeutics" course will be composed of a series of lectures on the key topics related to drug development. The goal of this course is to provide students with a translational view of drug development, from basic research to clinical implementation. The students are expected to learn about the biological, computational and clinical aspects of the development of cancer therapeutics and their associated biomarkers (companion tests). For each session, 3 groups of 2 students will be formed. The lecturer gives a 45-minute lecture. Each group will then present one paper (10 minutes presentation + 5 minutes for questions). The paper will be selected by the students from a set of 3 papers provided by the lecturer, as well as one question to be discussed by the students for each paper, 2 weeks prior to the session.	
Evaluation Method	Evaluation of the presentation (30%) + exam with multiple-choice questions (70%)	
Schedule		
Date	**Instructor**	**Lecture**
March 6	Benjamin Haibe-Kains & Federico Gaiti	Biomarker discovery in preclinical setting
March 13	Aaron Schimmer	Drug discovery and development
March 20	Shraddha Pai	Network-based drug repurposing
March 27	Geoffrey Liu	Pharmacogenetics and pharmacokinetics
April 3 [starts at 12.15pm]	David Cescon	Preclinical testing of experimental therapeutics
April 10	Philippe Bedard	Design of clinical trials for cancer therapeutics

April 17	Benjamin Haibe-Kains & Federico Gaiti	Evaluation - short exam with multiple-choice questions

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Winter 2023	
Topic	**MBP1301H: Radiation Oncology: Clinical & Experimental Radiobiology**
Coordinator	Dr. Marianne Koritzinsky
Day & Time	April 24 – 28, 10:00 am – 6:00 pm
Location	TBA
Recommended Prerequisites	The suggested textbook for this course is Basic Clinical Radiobiology, Fifth Edition. It is strongly recommended that you read this book before attending the course.
Module Goals	This program provides a comprehensive overview of radiation biology with a particular emphasis on aspects of direct relevance to the practice of radiation oncology. It addresses the molecular and cellular responses to radiation-induced damage that influence cell death in both tumors and normal tissues. Quantitation of radiation effects and the underlying biological basis for fractionation of radiotherapy and dose-response relationships in the clinic are covered in depth. The biological basis for current approaches to improve radiotherapy will be described including novel fractionation schemes, retreatment issues, targeting hypoxia, biological modifiers and combined radiotherapy/chemotherapy. Suggested textbook for this topic is: https://www.amazon.ca/Basic-Clinical-Radiobiology-Michael-Joiner/dp/1444179632 This topic is also offered through the Department of Radiation Oncology to residents in radiation oncology and physics, as well as other radiobiology researchers.
Evaluation Method	Exam (100% of the grade) on May 21st 9 AM – 12 PM – location TBA

Schedule

MONDAY, April 24, 2023			
Time	**Lecture**		**Faculty Speaker**
TBD		TBD	TBD

TUESDAY APRIL 25, 2023			
Time	**Lecture**		**Faculty Speaker**
TBD		TBD	TBD

WEDNESDAY APRIL 26, 2023			
Time	Lecture		Faculty Speaker
TBD		TBD	TBD

THURSDAY APRIL 27, 2023			
Time	Lecture		Faculty Speaker
TBD		TBD	TBD

FRIDAY APRIL 28, 2023			
Time	Lecture		Faculty Speaker
TBD			

Note: *Lectures/schedule is subject to change – Last updated on <date>*

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Winter 2023		
Topic	**MBP1302H: Structural Biology & Proteomics**	
Coordinator	Drs. Mohammad Mazhab-Jafari & Gil Privé	
Day & Time	Thursdays, 2 – 4 pm	
Location	PMCRT, 4-204	
Recommended Prerequisites	NONE	
Module Goals	This course offers six lectures in structural biology and proteomics. While the methodological basis for the techniques will be covered, the emphasis will be on what structural biology and proteomics teach us about biology. The course will address protein structure and dynamics, structures of membrane proteins, and structures of supramolecular assemblies. You will learn how various research tools such as X-ray crystallography, NMR spectroscopy, and electron microscopy are used to determine atomic-resolution structures of biological macromolecules (proteins, nucleic acids, carbohydrates, and lipids), with a special emphasis on macromolecular complexes and assemblies. The course will also focus on various applications of mass spectrometry-based proteomics, including the mapping of large-scale protein-protein interactomes and the global characterization of post-translational modifications in proteomes – advances that are revolutionizing our understanding of the molecular workings of biological systems.	
Evaluation Method	**Report or essay (to be confirmed)**	
Schedule		
Date	**Instructor**	**Lecture**
March 2	Gil Privé	Introduction to protein structure
March 9	Gil Privé	Proteins at high resolution: X-ray diffraction
March 16	Mohammad Mazhab-Jafari	Protein assemblies: electron cryo-microscopy
March 23	Geneviève Seabrook	Proteins in solution: nuclear magnetic resonance
March 30	Brian Raught	Protein interaction networks: mass spectrometry
April 6	Chris Marshall	Screening for ligands: biophysical methods
April 13	Mohammad Mazhab-Jafari and Gil Privé	Evaluation

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Medical Biophysics
UNIVERSITY OF TORONTO

Winter 2023		
Topic	**MBP1412H: Ultrasound Overview**	
Coordinator	Dr. Christine Demore	
Day & Time	Mondays & Fridays, 9:30 am – 2 pm	
Location	Sunnybrook, Room SG22	
Recommended Prerequisites	A foundation in signals and systems theory and Fourier transforms is required. Students are strongly advised to take the Overview of Medical Imaging module prior to this one.	
Module Goals	Ultrasound is a high-resolution and rapid imaging modality that applies high-frequency acoustic waves to create images based on echoes that are generated by acoustic impedance heterogeneity between different materials in a sample. Ultrasound imaging has many clinical applications from monitoring fetus in pregnancy, to diagnostic imaging of breast, abdomen and vasculature, and guiding interventional tools in minimally-invasive procedures. This course will introduce the principles of ultrasound imaging, starting with a general overview of this imaging modality and its applications. It will cover ultrasound beam profiles and the basic physics of ultrasound, interaction of ultrasound waves with tissue transducers, signal processing and image formation and beam forming, transducer design, flow detection, contrast imaging, and assorted topics. The lectures will be given over two intensive days on consecutive weeks, followed by the practical laboratory to reinforce the taught concepts.	
Evaluation Method	Lab report (50%) and exam (50%)	
Schedule		
Date	**Instructor**	**Lecture**
January 9	TBD	Introduction & history Basic physics and principles in ultrasonics
January 13	TBD	Image generation & quality Applications & Implementations Practical Lab
January 16	TBD	System & signal analysis Applications & Implementations
January 20	TBD	Doppler & colour flow imaging, Contrast imaging Applications and Implementations Lab (possibility virtual) with TAs (3 hours; times finalized during lectures)
March 10	**Exam**	

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