Laboratory Medicine & Pathobiology
UNIVERSITY OF TORONTO

LMP1100H - Cellular Imaging in Pathobiology

This course explores the powerful intersection of Physics, Biological science, and Imaging technologies. Basic principles of optics such as light, diffraction, refraction, the nature of lenses, and the design of the light microscope, the latest image analysis tools, artificial intelligence (AI), and machine learning software for image analysis digital pathology will be covered in this course. We will discuss phase contrast, darkfield, interference contrast, modulation contrast, polarization and fluorescence microscopy. Different types of microscopes and imaging technologies and their use in biological sciences, including dissecting, compound, scanning and transmission electron microscopes, positron emission tomography, single-photon emission computed tomography, nuclear magnetic resonance imaging, ultrasound, optical imaging, stereology, live cell and whole animal imaging techniques and their use in diagnostic pathology will be discussed. Lectures will be complemented by laboratory sessions demonstrating these systems. This course will focus on the theory, application and implementation of different imaging techniques and, more importantly, on the application of biological experimentation relevant to modern biological research or clinical, biochemical studies and the common real-life research goal in the industry, hospitals and research laboratories.

Objective: At the end of this course, participants are expected to have acquired knowledge about different types of image analysis tools and software, microscopes, advanced imaging technologies and their functionality and use in biological sciences. The course will provide students with the knowledge and expertise to implement cutting-edge microscopic and imaging methods within their laboratories.

Course Title and ID: Cellular Imaging in Pathobiology (LMP1100H)
(This course is offered in odd years (i.e. years ending in 1,3, etc.) in the Winter session).

2023 Schedule: February 7 to March 14, 2023 (Tuesdays from 10 AM-12 Noon EST)
Course Delivery Mode: In-person

Curriculum: Lectures consist of theory on image analysis tools, microscopy, various imaging instruments and research facility tours and instrument demonstration.

Prerequisite: No specific courses are required; however, students should have completed advanced studies in molecular biology, cell biology or biochemistry. Priority will be given to more senior PhD students.

Course Details (0.25 FCE course timetable)
Evaluation:
60% Participation in all lectures and laboratory sessions
40% Grant proposal

Course Coordinator: Sima Salahshor, PhD
Adjunct Professor, Department of Laboratory Medicine and Pathobiology (LMP)
Temerty Faculty of Medicine, University of Toronto
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Program details

February 7, 2023
1 King's College Circle, Medical Sciences Building (MSB), Room #MS 2394

Picturing Science: An Overview of Imaging Technologies

Dr. Sima Salahshor
Department of Laboratory of Medicine & Pathobiology
Temerty Faculty of Medicine, University of Toronto

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February 7, 2023
1 King's College Circle, Medical Sciences Building (MSB), Room #MS 2394

Breaking Down Tissue: HALO Quantitative Tissue Analysis.

Dr. Amber L. Ortiz and Spencer Revill and Maciej Zerkowski
Indica Labs, Quantitative Pathology

E: aortiz@indicalab.com **E:** srevill@indicalab.com **E:** mzerkowski@indicalab.com URL: www.indicalab.com

Synopsis (part 1): Some of the latest imaging technologies used in clinics and research laboratories will be reviewed.

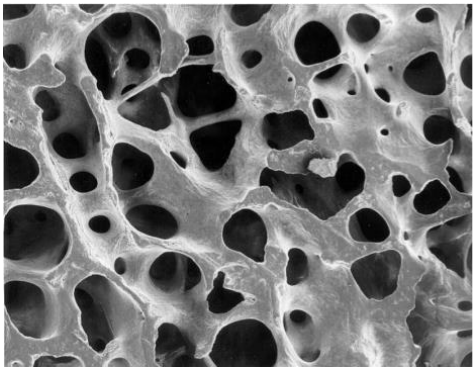
Synopsis (part 2): Digital pathology and quantitative image analysis will be covered.

February 14, 2023
The Hospital for Sick Children Research Institute
Advanced Bioimaging Centre & Departments of Biochemistry and Medical Biophysics
Rm# 06-9701 & Rm# 06-9621, 686 Bay Street, The Hospital for Sick Children Research Institute

Principle of Scanning (SEM) and Transmission Electron Microscopy (TEM)

Dr. Ali Darbandi

E: ali.darbandi@sickkids.ca
URL: https://lab.research.sickkids.ca/imagingfacility/
URL: https://lab.research.sickkids.ca/nbif/cmem/



Synopsis: General principles underlying electron microscopes and differences between scanning and transmission microscopes will be discussed.

February 21, 2023
1 King's College Circle, Medical Sciences Building (MSB), Room #MS 2394

Digital Pathology and AI in Preclinical Studies, Translational Medicine and Clinical Practice.

Dr. Trevor McKee
Deciphex, Inc.

E: trevor@pathomics.io
URL: https://www.deciphex.com/

Synopsis: TBA

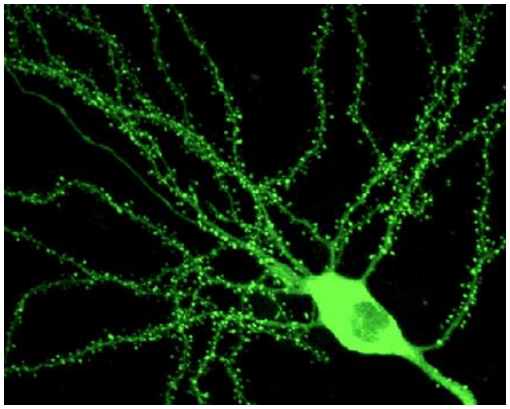
February 28, 2023
Medical Sciences Building Room 3214, Centre for Optophysiology
Department of Physiology, University of Toronto, 1 King's College Circle

Application of Two-Photon Microscopy for Cellular Imaging and Photoactivation

Dr. Kenichi Okamoto & Dr. John Georgiou

E: okamoto@lunenfeld.ca **| E:** georgiou@lunenfeld.ca
URL: http://www.lunenfeld.ca/researchers/okamoto
URL: https://www.lunenfeld.ca/?page=georgiou-john

Synopsis: Two-photon microscopy is suitable for deep tissue imaging using infrared light pulses, allowing photoactivation within a small volume. This lecture will outline two-photon microscopy principles and demonstrate applications of live photoactivation techniques combined with imaging of fluorescent probes in living brain sections. In addition, we will discuss molecular and cellular imaging, two-photon photoactivation of protein activity and imaging at the synapse level.



March 7, 2023
Room #7-211, 101 College Street, East Elevators, 7th Floor, STTARR, MaRS

Introduction to Preclinical Imaging and STTARR Facility Tour- (Spatio-Temporal Targeting and Amplification of Radiation Response)

Dr. Warren Foltz, Deborah Scollard, Teesha Komal, Alex Wang, Dr. Luke Kwon, Dr. Naz Chaudary

E: naz.chaudary@uhnresearch.ca
URL: https://www.sttarr.com/

Synopsis: This lecture will explore the application of in-vivo imaging techniques (MRI, CT, PET/SPECT, IGRT, ultrasound, and optical imaging) in preclinical research. Scaled down, high resolution versions of these imaging systems are used at STTARR to visualize small-animal models of disease and evaluate the efficacy of corresponding diagnostic and therapeutic methods.

March 14, 2023
1 King's College Circle, Medical Sciences Building (MSB), Room #MS 2394

Magnetic Resonance Imaging: Diagnostic and Prognostic Biomarkers of Multiple Sclerosis

Dr. Mohammad Ebrahimzadeh & Dr. Tae Joon (TJ) Yi
Lucidpsycheceuticals, Inc (An FSD Pharma company)

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URL: https://www.lucidpsycheceuticals.com/ | **URL:** https://fsdpharma.com/

Synopsis: The first part of this lecture will provide an overview of the histopathological and clinical manifestations of multiple sclerosis (MS) and the second part will focus on the utility of magnetic resonance imaging (MRI) in research and clinical practice in the MS therapeutic area.

MS is a debilitating chronic autoimmune disease of the central nervous system (CNS; brain, spinal cord, and optic nerve, etc) that can lead to impairment of vision, memory, balance, and mobility. These impairments are hypothesized to be, at least in part, the result of myelin sheath damage, following immune cell infiltrations of the CNS. The myelin sheath is the protective outer layer of nerve fibers. Since the myelin is necessary for the transmission of nerve impulses through nerve fibers, their damage will disrupt the transmission of nerve impulses. The areas of myelin damage in the CNS are called inflammatory demyelinating lesions.

Recent advancements in MRI technology have made it possible to visualize these lesions and other biomarkers of MS. As such MRI is quickly emerging as an important paraclinical tool for diagnosis, prognosis, monitoring disease progression, and treatment-response assessments. In addition, the use of MRI in research studies has advanced our understanding of disease mechanisms underlying the histopathology of MS.