Offered: in odd years (i.e. years ending in 1,3, etc.) in the Winter session	
Course Name	**LMP1100H - Cellular Imaging in Pathobiology**
Coordinator(s)	Dr. Sima Salahshor
Day and Time	Tuesdays from 10 AM to 12 Noon
Location	Online (link to be provided by Dr. Salahshor)
Prerequisites	No specific courses are required; however, students should have successfully completed advanced courses in molecular biology, cell biology and/or biochemistry.
Module Goals	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 own laboratories.
Evaluation Method	**Writing a funding application** The grant proposal format designed specifically for this course. The proposed project should include at least one imaging technology. The application will be assessed on the basis of scientific merit (see course summary below).

Schedule (February 2 to March 9, 2021 (Tuesdays from 10 AM-12 Noon EST)

Date	Instructor	Lecture
Lecture 1 (Feb 2, 2021)	Dr. Sima Salahshor	(1) Picturing Science: An Overview of Imaging Technologies; (2) Novel Imaging Technologies: From Prototype to Product
Lecture 2 (Feb 9, 2021)	Dr. Sergio Grinstein, Paul Paroutis & Dr. Kimberly Lau	An Overview of the Fundamentals of Fluorescence Microscopy
Lecture 3 (Feb 16, 2021)	Dr. Ali Darbandi	Principle of Scanning (SEM) and Transmission Electron Microscopy (TEM)
Lecture 4 (Feb 23, 2021)	Dr. Susan Camilleri	Microscopic Analysis and Interpretation in Veterinary Pathology
Lecture 5 (March 2, 2021)	Dr. Kenichi Okamoto & Dr. John Georgiou	Application of Two-Photon Microscopy for Cellular Imaging and Photoactivation
Lecture 6 (March 9, 2021)	Dr. Hamid Tizhoosh	How Artificial Intelligence (AI) Transforms Digital Pathology

Cellular Imaging in Pathobiology

LMP1100H (2021)

Cellular Imaging in Pathobiology

February 2 to March 9, 2021

Department of Laboratory of Medicine and Pathobiology (LMP)
Temerty Faculty of Medicine, University of Toronto (UofT)

URL: https://www.lmp.utoronto.ca/
Twitter: @LMP_UofT

Course Coordinator: Dr. Sima Salahshor
E: s.salahshor@utoronto.ca

Laboratory Medicine & Pathobiology
UNIVERSITY OF TORONTO

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, 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, and modulation contrast, as well as 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 and 3D imaging, optical microscopy, nanoscopy, live cell and whole animal imaging techniques, cytogenetic, X-ray crystallography and imaging in forensic science and their use in diagnostic pathology will be discussed. Lectures will be complemented by online 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).

2021 Schedule: February 2 to March 9, 2021 (Tuesdays from 10 AM-12 Noon EST)

Course Delivery Mode: Online Synchronous (attendance is expected at a specific time for all course activities). Lectures and live laboratory video sessions will be delivered via the Zoom app. Instruction will be provided before the course start.

Curriculum: Lectures consist of theory on image analysis tools, microscopy, various imaging instruments, via video or live online 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): https://www.lmp.utoronto.ca/lmp-course-list

Evaluation:
1) **40%** Participation in online lectures and live laboratory video sessions
2) **60%** Grant Proposal

The grant proposal format designed specifically for this course consists of the following subsections: **Significance, Innovation, Approach, Financials** and **Product Summary**. The grant proposal should include at least one imaging technology. The application will be assessed based on scientific merit. It will be reviewed and judged based on: (1) how original the project is, (2) how well the project is planned, (3) how well the proposal budget is developed, and (4) what are the benefits that may result from this project? Course participants are encouraged to seek mentorship from an imaging technology expert for the specific method used in their grant proposal.

Course Coordinator:
Sima Salahshor, PhD, PMP
Adjunct Professor, Department of Laboratory Medicine and Pathobiology (LMP)
Temerty Faculty of Medicine, University of Toronto
E: s.salahshor@utoronto.ca | T: (+1) 416-841-7959

February 2, 2021

(I) <u>Picturing Science: An Overview of Imaging Technologies</u>
(II) <u>Novel Imaging Technologies: From Prototype to Product</u>

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

E: s.salahshor@utoronto.ca
URL: https://www.lmp.utoronto.ca/faculty/sima-salahshor | www.Shiruy.com

Synopsis: In the first part of this session, an overview of the course and grant proposal writing (including the principles of market research, marketing, business development, IP rights, proposal writing, budget development, and how to prepare compelling product pitches and to present proposals to funding agencies and private investors) will be provided. In the 2nd part, some of the latest imaging technologies used in clinics and research laboratories will be reviewed.

February 9, 2021

(I) <u>An Overview of the Fundamentals of Fluorescence Microscopy</u>
(II) <u>Advanced imaging techniques: principles and applications</u>

Dr. Sergio Grinstein, Paul Paroutis & **Dr. Kimberly Lau**
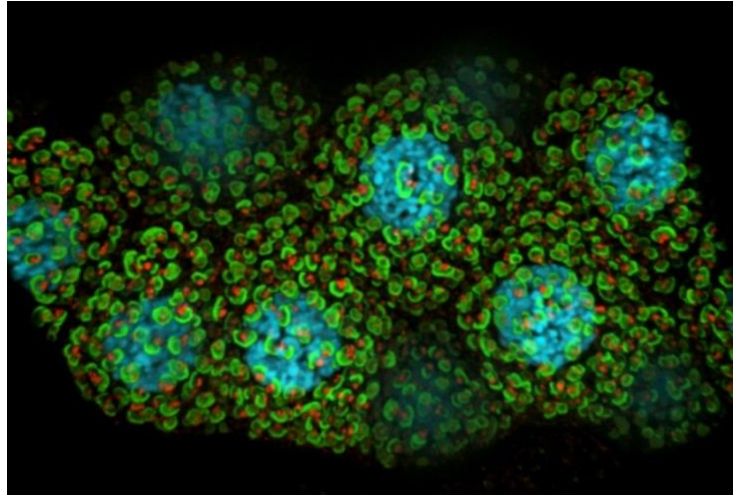The Hospital for Sick Children, University of Toronto, Department of Biochemistry

E: sergio.grinstein@sickkids.ca | E: kimberly.lau@sickkids.ca | E: paul.paroutis@sickkids.ca
URL: www.sickkidsimaging.ca
URL: http://biochemistry.utoronto.ca/person/sergio-grinstein/

Synopsis (I): This lecture will cover the basic principles and describe the equipment necessary to visualize fluorescently labelled specimens (both live and fixed). The topics featured will include the fundamentals of fluorophore absorption/excitation/emission, and microscope and camera optics. The goal is to familiarize students with the theoretical and practical aspects behind fluorescence microscopy, focusing on cellular imaging.

Synopsis (II): This lecture will focus on the principles behind two super-resolution microscopy technologies: Lightning (confocal microscopy with integrated deconvolution) and stimulated emission depletion (STED) microscopy. These techniques enable image acquisition of both live and fixed specimens at resolutions of 1.5x – 4x greater than conventional fluorescence microscopy. The theory and application of these techniques will be discussed, followed by a live demonstration.

February 16, 2021

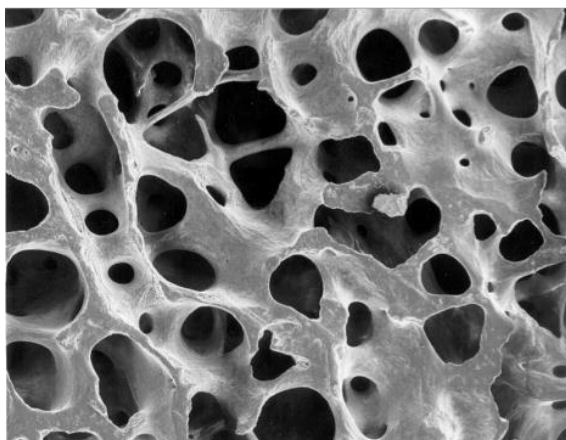**Principle of Scanning (SEM) and Transmission Electron Microscopy (TEM)**

Dr. Ali Darbandi
The Hospital for Sick Children Research Institute
Advanced Bioimaging Centre & Departments of Biochemistry and Medical Biophysics

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 microscope and differences between scanning and transmission microscopes will be discussed.

February 23, 2021

<u>Microscopic Analysis and Interpretation in Veterinary Pathology</u>

Dr. Susan Camilleri
The Centre for Phenogenomics Pathology Core,
Digital Comparative Pathologist; Mount Sinai Hospital

E: Camilleri@lunenfeld.ca
URL: http://phenogenomics.ca/index2.html?v=1
URL: https://www.lmp.utoronto.ca/faculty/susan-camilleri

Synopsis: TBA

March 2, 2021

<u>Application of Two-Photon Microscopy for Cellular Imaging and Photoactivation</u>

Dr. Kenichi Okamoto & Dr. John Georgiou
Mount Sinai Hospital, Lunenfeld-Tanenbaum Research Institute

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 infra-red 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. We will discuss molecular and cellular imaging, two-photon photoactivation of protein activity and imaging at the synapse level.
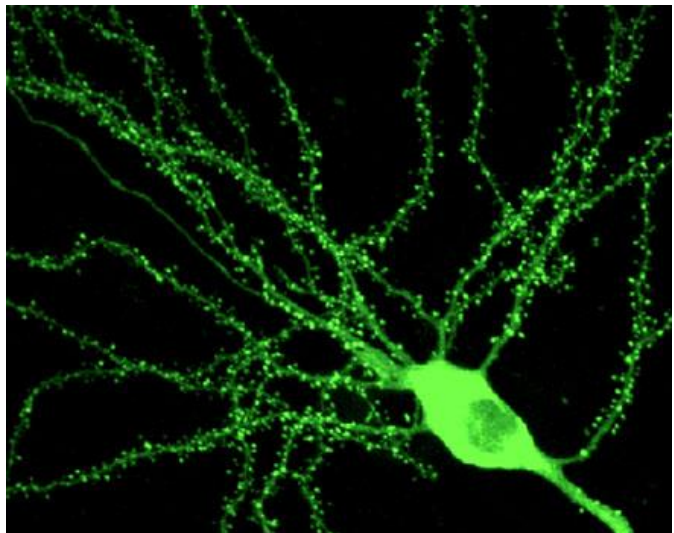
March 9, 2021

<u>How Artificial Intelligence (AI) Transforms Digital Pathology</u>

Dr. Hamid Tizhoosh
Faculty of Engineering at the University of Waterloo
KIMIA Lab (Laboratory for Knowledge Inference in Medical Image Analysis)

E: tizhoosh@uwaterloo.ca
URL: https://kimialab.uwaterloo.ca/kimia/

Synopsis: TBA