UNIVERSITY OF TORONTO
ECE1475H Bio-Photonics (cross listed in BME and ECE)

July 28, 2026

GENERAL COURSE INFORMATION – Winter 2027

Course instructors

Instructor Ofer Levi , ofer.levi@utoronto.ca

Background materials

1. Background course in optics, for example *ECE318H1: Fundamentals of Optics* .
2. *Fundamentals of Photonics* , 3rd edition by B. E. A. Saleh and M. C. Teich, *available online*.
3. *Photonics*, 6th edition, by Amnon Yariv, *available at the UofT library*.
4. *Optics*, by Eugene Hecht, 4th edition or higher, *available at the UofT library.*
5. *Biophotonics Concepts to Applications*, 2nd edition, by Gerd Keiser, *available online*.
6. Undergraduate studies background in anatomy, physiology, and cellular and molecular interactions, related to understanding the applications of optical techniques in biomedical studies.

Course Website: access via *Quercus*. Course notices and handouts will be posted to this website.

Course schedule : Lecture Wed. 15:10 – 17:00 ; Tutorial Wed. 17:10 – 18:00

Composition of Final Mark:

Final exam	50%	(individual mastery)
Assignments	10%	(individual mastery)
Student Presentation	15%	(individual mastery)
Final report (last week)	15%	(individual mastery)
Participation	10%	

Course description

This graduate course is open to both Biomedical engineering and Electrical engineering graduate students who want to broaden their knowledge in Biophotonics and apply it to their future research activities. We will look at Bio-photonics from an engineering perspective, and will review basic principles as well as the instrumentation (imaging and sensing systems) that are used in this field. We will include hands on assignments and demonstrate simulation tools in optical biosensing and imaging. There are 10 -11 weekly lecture sessions, and a student seminar presentation by the end of the semester.

Learning Outcomes

The learning outcomes include:

(1) Reviewing the fundamentals in interaction of light with tissue.

(2) Describing basic processes such as Absorption, Scattering, Fluorescence.

(3) Understanding the design of micro and nano-fabricated bio-sensors.

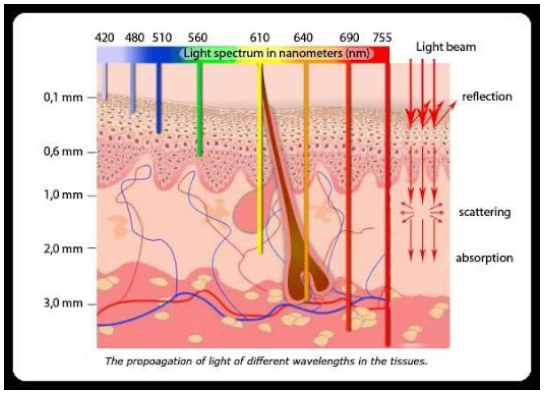
(4) Discussing major sensing figures of merit such as resolution, sensitivity, detection limits.

(5) Evaluating parameters such as field of view, resolution, dynamic range and image multiplexing in optical microscopy techniques.

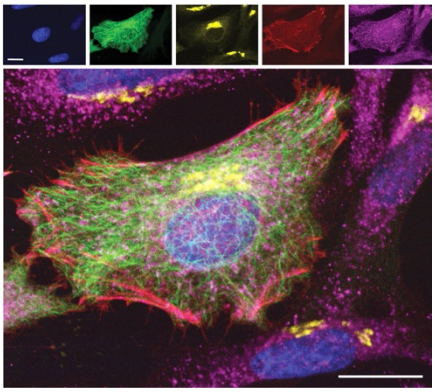
(6) Characterizing in vivo imaging systems for tissue imaging in brain and cancer studies.

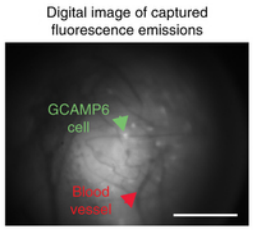
(7) Understanding optical spectroscopy techniques such as Raman, fluorescence, lifetime, FRET spectroscopy techniques and their application to single molecule studies.

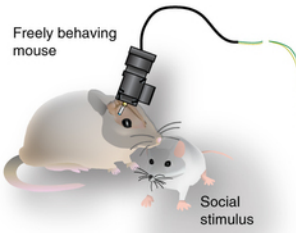
Example topics we will review:



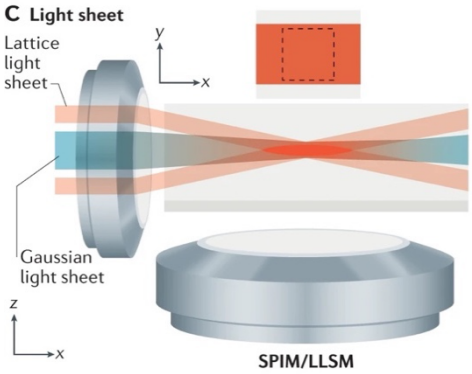
Light interaction with tissues

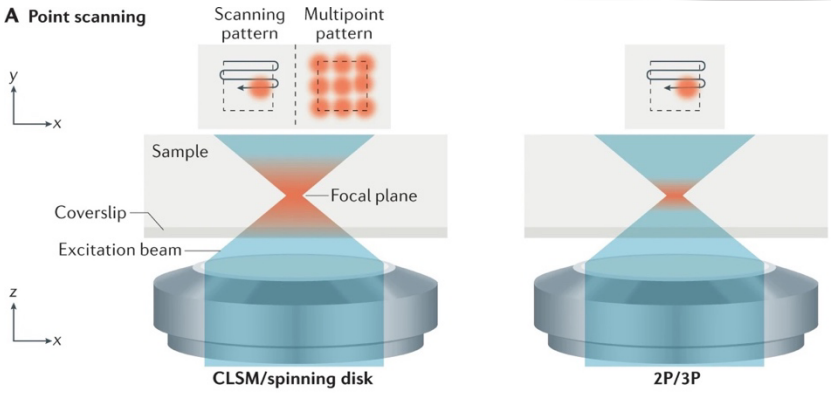




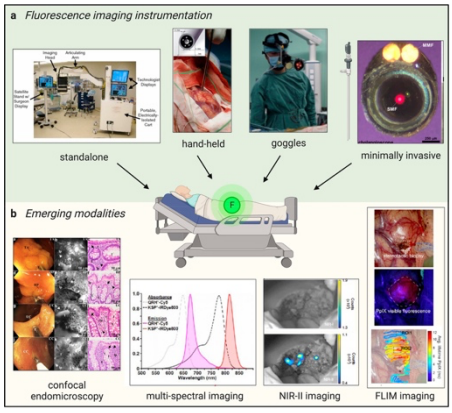


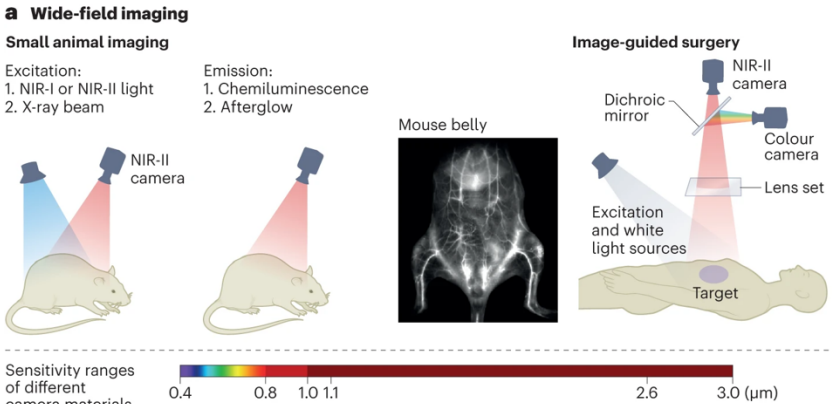
Optical fluorescence microscopy





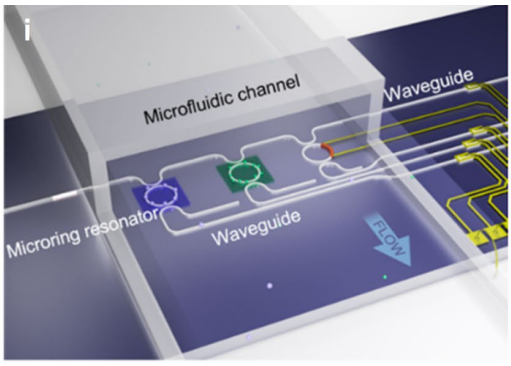
Advanced microscopy techniques

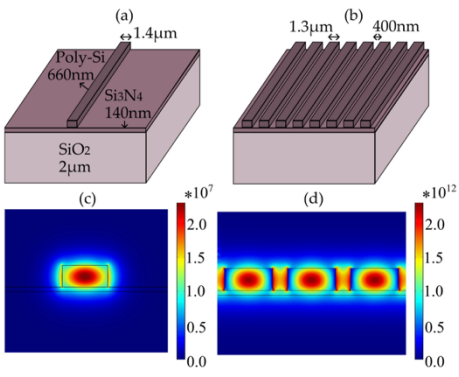




In vivo imaging techniques

Optical biosensors





Optical spectroscopy