Microscopy

Principles and Applications

course syllabus | spring 2015

Jan 20th – May 21st
Tuesdays, 11 – 12:15 pm
Thursdays, 11– 12:15 pm

Neuroscience
Research Building
Room 3118

Vladimir Ghukasyan
115 Mason Farm Rd.
Bld. 245, Rm. 7109F

919.966.5807
v.gukassyan@gmail.com

This course aims to provide the knowledge one may need to understand the reach of microscopy imaging techniques, to be able to choose the right imaging modality, label the sample, carry out the experiment, analyze data and troubleshoot any pitfalls that may occur.

We will start from the principles of microscopy, proceed to the description of conventional and advanced modern techniques, and evaluate advantages and disadvantages of each method. You will understand what studies can be addressed with each technique and what is the level of details that can be expected. Applications of microscopy will be illustrated with the review of recent research with the focus on Neuroscience.

This semester **special attention will be paid to hands-on demonstrations**. We will spend a lot of time with the imaging instruments and sample preparation equipment. We will also spend some time with data analysis software and practice with data presentation formats

15 lectures 9 hands-on demonstrations

- **Fundamentals of Optics** (2 lectures)
  An outline of the principles underlying the field of microscopy – from the properties of light to image formation.
- **Light-matter interactions** (1 lecture)
  What happens when the light hits a sample? Basics of fluorescence and phosphorescence.
- **Widefield Microscopy** (1 lecture | 2 hands-ons)
  Principles of operation and alignment of a widefield microscope. Discussion of limitations
- **Confocal Microscopy** (2 lectures | 2 hands-ons)
  Principles, advantages, limitations, and anatomy of a confocal microscope. Pitfalls and remedies.
- **Multiphoton Microscopy** (1 lecture | 2 hands-ons)
  Advantages, basic setups and related instrumentation. Basics of multiphoton imaging.
- **Labeling and Sample Preparation** (1 lecture | 1 hands-on)
  Labels for live and fixed samples. How to prepare samples and label them. What are the problems to expect and how to solve them.
- **Advanced Microscopy Techniques** (2 lectures)
  New developments in microscopy: overview of Forster resonance energy transfer (FRET), fluorescence lifetime imaging (FLIM), superresolution techniques (STED, STORM, PALM, SIM), single-molecule techniques, etc.
- **Biosensors and photomanipulation** (1 lecture)
- **Image Processing and Data Analysis** (2 lectures | 2 hands-ons)
  Methods, algorithms and software.
- **Microscopy Applications** (2 lectures)
  A wide scope of biomedical studies with application of different microscopy techniques