Syllabus
"Biological Optical Microscopy"
BME 650

Proposed Time and Location:
Tuesdays-Thursdays
11-12:15

Course Description:
This course will cover several aspects of state of the art biological and biophysical imaging. We will begin with an overview of geometrical optics and optical and fluorescence microscopy, with an emphasis on instrumentation. The bulk of the course will focus on advanced imaging techniques, including nonlinear optical processes (multi-photon excitation, second harmonic generation, and stimulated Raman processes), as well as emerging super-resolution methods. Special emphasis will be given to current imaging literature and experimental design. Upon completing the course, students should gain fundamental and practical knowledge in designing microscopy experiments. Students should also gain experience in critically reading current literature.

Prerequisites: Sr undergrad or grad standing, AND an intro Chem (104 or 109 or 116) AND an intro Physics (104 or 202 or 208).

Learning Outcomes
1. Students will be able to provide a clear, concise oral presentation critiquing a paper in the literature.
2. Students will be able to write a hypothesis driven research proposal and present an oral defense.
3. Students will be able to write a critical written assessment of literature papers.
4. Students will be able to use course concepts to better design their experiments and extract quantitative information.
5. Students will gain a fundamental understanding of the function of a microscope.

Course Evaluation
A) Homework / paper critiques: 35%
Homework problems are in the form of questions related to material in lecture notes, or a written critique on one of the papers assigned as the weekly reading materials.

Problem sets will be graded as A, A/B, B, B/C, C, D or F

Homework will be due one week after assigned, unless otherwise specified. Late homework may be accepted, but penalized.

Each week reading material consisting of articles from the literature will be assigned. A one page summary and critique on one of these papers (assigned by the instructor) will be due each week.

B2) Two Class Presentations: 20%

~25 minute Powerpoint summary of assigned paper from recent literature related to class topic
Presentations will be graded as A, A/B, B, B/C, C, D or F

C) In class midterm: 10%
Exams will be graded as A, A/B, B, B/C, C, D, or F

D) Final project 35%
Hypothetical written NIH style grant proposal with oral presentation based on techniques learned in the class.
Projects will be graded as A, A/B, B, B/C, C, D or F

Final grades will be assigned as A, A/B, B, B/C or C

For all components, A corresponds to 90-100%, A/B:85-89%, B:80-84%, B/C 75-79% C: 70-74%, D:60-69%, and F<60%.

Graduate and Undergraduate grading protocol
Beginning in Fall 2014, the University requires that assessment of graduate and undergraduate students be performed differently for courses to count as graduate credits. To satisfy this requirement, the work of graduate students will be assessed more stringently than that of undergraduate students.

Attendance
Attendance is not required but highly encouraged. As this class meets twice a week, missing one class translates to missing significant material.

Academic Misconduct
There is a zero-tolerance policy in this course for any form of cheating, plagiarism or other type of academic misconduct.

Library websites
Much of the assigned reading (in addition to assigned oral presentations) will be journal articles available at the UW-Madison library

Class Resources:
Web sites to supplement reading and lecture notes
Molecular Expressions Microscopy Primer
http://micro.magnet.fsu.edu/primer/

Nikon University (related)
http://www.microscopyu.com/

Optics Tutorial
http://www.lasertechonline.org/optics_links.html#quantum

CVI/MellesGriot Laser web site: basic optics
http://www.cvimellesgriot.com/Company/Glossary.aspx?Character=O

Textbook
Textbook: "Fundamentals of light microscopy and electronic imaging"
Douglas Murphy
ISBN: 0-471-25391-x (Amazon)
Optional

Freshman Physics textbook may be helpful

Contact Information
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Class Schedule

Lecture 1	Optics review
Lecture 2	Microscope Basics/ Kohler illumination
Lecture 3	Phase/DIC/polarization microscopy
Lecture 4	Phase/DIC/polarization microscopy paper presentations
Lecture 5	Introduction to fluorescence
Lecture 6	Fluorescence microscopy
Lecture 7	Confocal microscopy I
Lecture 8	Confocal microscopy II
Lecture 9	Confocal microscopy paper presentations I
Lecture 10	Confocal microscopy paper presentations II
Lecture 11	Introduction to nonlinear optics
Lecture 12	confocal papers: SPIM, variants
Lecture 13	two-photon microscopy I
Lecture 14	two-photon microscopy II
Lecture 15	two-photon paper presentations
Lecture 16	Second Harmonic Generation I
Lecture 17	Second Harmonic Generation II
Lecture 18	Second Harmonic Generation paper presentations
Lecture 19	Coherent anti-Stokes Raman Scattering
Lecture 20	Coherent anti-Stokes Raman Scattering paper presentations

Lecture 21	In class exam
Lecture 22	FRET/FLIM Microscopy
Lecture 23	FRET/FLIM Microscopy paper presentations
Lecture 24	FRAP/FCS
Lecture 25	FRAP/FCS paper presentations
Lecture 26	Super-resolution microscopy
Lecture 27	Super-resolution microscopy paper presentations
Lecture 28	Nanoscale optical probes
Lecture 29	Adaptive optics/novel techniques
Lecture 30	Review

Final Presentations in Final week