Biology 542 –Syllabus –Fall 2019

Light Microscopy for Biology and the Biomedical Sciences

P.S. Maddox and Kerry Bloom

Class: Tues, Thurs: 3:30-4:45, Genome Sci Bldg. 1374

Microscopy Book: Fundamentals of Light Microscopy and Electronic Imaging, Douglas Murphy, Wiley-Liss, 2001 (available on Sakai web site)

Handouts in Class: TBA

Grades: 3 Take-Home Exams, Presentations

TENTATIVE SCHEDULE

Aug 20 Introduction: Theory of Light

Discussion of life inside a cell K. Bloom

22 Reflection, Refraction, Interference

27 The Origins and Evolution of Light Microscopy for Biology

29 Geometrical optics and basic imaging light paths (15-50)

Basic illuminating light paths, conjugate image planes (1-13)

Sept. 3 Microscope assembly, alignment, identification of major components, identification of conjugate image planes, measure NA, (29-42)

5 Wave optics of image formation, resolution, diffraction, Objective Point Spread Function, Diatoms as resolution test specimens (61-95)

Dark field and Phase Contrast Microscopy (95-116)

Sept. 10 Polarized light interaction with matter (117-133) P. Maddox

12 Polarization, DIC microscopy (135-175) P. Maddox

17 Polarization and DIC microscopy (135-175) K. Bloom

Take Home Exam I

Sept 19 Introduction to fluorescent probes, their fundamental properties and how they can be used as bio-sensors

24 Paper presentations

26 GFP and its derivatives

Oct 1 Applications of Multi-wavelength GFP, YFP, CFP and DIC imaging in budding yeast GFP live cell biology

Practical Applications, counting molecules, nanometer localization accuracy in wide-field

3 Model Convolution: The role of mathematical modeling in microscopy

8 Paper presentations

Oct. 10

Oct. 15

Take-Home Exam II, to be Returned at End of Break

FALL Break

Start P. Maddox

Oct. 22 Intro. Super-Resolution Microscopy: SHREC, SIM, PALM, STORM,

24

. 29 Intro. Video and Digital Cameras, digital images, digital image acquisition, microscope control: A Multi-Mode Digital Imaging

Microscope (MetaMorph and Image J; 236-238; 260-267; Image J Instructions)

Nov 5 Point Scanning Confocal and Multi-photon Microscopy:

Basic concepts and practical aspects (205-231)

7

12 Getting quantitative information from photon counting to digital images and digital image processing (259-281)

Nov. 14 3-D Image De-Convolution

19 Advanced Fluorescence Methods: FRAP, FLIP, FRET, TIRF

21 Examples of Single Molecule Imaging of protein function with TIRF

Examples of FRET BioSensors: phosphorylation, tension ......

26 Cell based screening for identifying functional proteins

Dec. 3 Presentation Journal Articles

5 Presentation Journal Articles

Professor’s Maddox and Bloom reserve the right to change this syllabus at any time.