**The Foundations and Future of Fluorescence Microscopy**

Biomedical Engineering PhD Student Qualifying Exam

Take home exam to be distributed 05/13/24

**Due: 05/17/24 – 5pm EST**

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**Goals and Learning Objectives:**

* Understand the principles of geometric and Fourier optics and their application to microscopy
* Analyze the advantages and tradeoffs of conventional, super-resolution, and light sheet microscopy approaches and their applications to biological questions.

**Format (100 pts total):**

* The exam will consist of a combination of multiple choice, short answer, and experimental design questions
* Students may use outside resources to answer the questions, but must work independently on their answers.
* Content of questions will come directly from the provided resources or from new information provided as part of the exam
* Students may wish to do additional reading that reinforces their understanding of the techniques/approaches used in the provided papers, but this is not required.
* It is suggested that students read through and familiarize themselves with the materials prior to receiving the exam.

**Resources:**

**Basic principles of optical imaging**

1. Fundamentals of Photonics – Basic Geometrical Optics by Leno S. Pedrotti
2. Fundamentals of Photonics – Basic Physical Optics by Leno S. Pedrotti
3. Wolf DE – The Optics of Microscope Image Formation, Methods in Cell Biology, 2007

**Super-resolution microscopy**

1. Sigal YM - Visualizing and Discovering Cellular Structures with Super-Resolution Microscopy, Science, 2018
2. Vangindertael J, An introduction to Optical Super-resolution Microscopy for the Adventurous Biologist, Methods Appl Fluoresc, 2018
3. Chen F, Expansion Microscopy, Science, 2015

**Live cell imaging and phototoxicity**

1. Laissue PP, Assessing Phototoxicity in Live Fluorescence Imaging, Nat Meth, 2017
2. Waeldchen S, Light Induced Cell Damage in Live-cell Super-resolution Microscopy, Sci Rep, 2015
3. Killian N, Assessing Photodamage in Live-cell STED Microscopy, Nat Meth, 2018