

Syllabus
OSE 4721 Biophotonics
Fall 2016

Location: CREOL 102

Day & Time: Tuesday & Thursday; 4:30 pm - 5:45 pm

Number of credits: 3 hours

Instructor:

Kyu Young Han (Assistant Professor of CREOL)

Email: kyhan@creol.ucf.edu

Office hours:

Tuesday 5:45 pm - 6:45 pm (Office: CREOL 162)

Prerequisites:

Not specifically required but OSE 3052 (Introduction to Photonics) would be a helpful course.

Textbook:

None. Lecture notes will be provided.

Other useful texts:

“Introduction to Biophotonics”, Paras N. Prasad, Wiley-Interscience (2003)

“Biophotonics: Concepts to Applications”, Gerd Keiser, Springer (2016)

“Physical Biology of the Cell”, Rob Phillips, Garland Science (2012)

Grading:

Quizzes 40 % (5 % x 8), Presentation 20 %, Final exam 40 %

Student presentation:

The students will choose an interesting (and relevant) topic from recent papers and present it for 15 min.

Course synopsis:

Biophotonics is an emerging multidisciplinary field where *light-based methods* are utilized to reveal biological mechanisms, and diagnose/treat several diseases. This course introduces the basics of biology and photonics, and provides the most relevant and important application examples selected from chemistry, biology, pharmacology and medicine. For examples, it includes how to detect and identify new viruses and how to manipulate the brain of mouse with light, etc. More than ten Nobel prizes will be mentioned during the lecture. No prior knowledge is required to take the course; however, basic knowledge of optics will be helpful.

A main goal of the lecture is to help the students become familiar with the field and thus they will be able to understand language of biology and photonics, and digest contemporary biophotonics techniques.

List of topics

1. Overview of Biophotonics (0.5 week)
 - Biology and Biophotonics
 - Medicine/Clinics and Biophotonics
2. Fundamentals of Biology (0.5 week)
 - The facts of life (Building blocks, central dogma, components of cells...)
 - Biology by the numbers
3. Basics of light-matter interactions in molecules, cells and tissues (1.5 weeks)
 - Nature of light
 - Refraction, reflection, interference, diffraction
 - Intensity, phase, polarization, scattering, Raman, fluorescence
 - Optical properties of bio-materials
4. Central dogma #1: DNA (1 week)
 - How to use light to find out information of our genomes: DNA sequencing
 - DNA replication/repair
 - Illumina and PacBio sequencing
 - Virus detection and identification using PCR
5. Central dogma #2: RNA (1 week)
 - Why is each tissue different from others?
 - DNA to RNA transcription
 - Count RNA numbers in cells/tissues: qPCR and RNA-FISH
6. Central dogma #3: Proteins (1.5 weeks)
 - Enzyme, antibody
 - Every cell has different gene expression level: Flow cytometry
 - Dissect folding dynamics of proteins: Single molecule FRET
 - Drug screening: SPR sensor
7. Bioimaging #1: Non-fluorescence-based microscopy (1.5 weeks)
 - Bright-field/Phase contrast/Dark-field/DIC microscopy
 - Raman imaging (SRS microscopy)
8. Bioimaging #2: Fluorescence-based microscopy (1.5 weeks)
 - Fluorophores (Green fluorescent proteins...)
 - Epi/Confocal/TIRF microscopy
 - Super-resolution fluorescence imaging
9. BRAIN initiative (0.5 week)
 - Interrogate brain with light: Optogenetics
 - Deep tissue imaging with multi-photon microscopy & light-sheet microscopy
10. Diagnosing diseases with light (1.5 weeks)
 - Endoscopy
 - Optical coherence tomography (OCT): Application to ophthalmology
 - Photoacoustic tomography: Application to early cancer detection
11. Treatment of diseases with light (1.5 week)
 - Killing cancer cells with light: Photodynamic therapy
 - Tissue engineering with light

Course schedules (It can be changed. Please refer to the course [website!](#))

Week	Date		Lectures	Notes
	Tue	Thu		
1	8/23		1. Overview of Biophotonics	
1		8/25	2. Fundamentals of Biology	
2	8/30		<i>No class (SPIE conference)</i>	
2		9/1	3. Basics of light-matter interactions	#Q1
3	9/6	9/8	3. Basics of light-matter interactions	
4	9/13	9/15	4. Central dogma #1: DNA	#Q2
5	9/20	9/22	5. Central dogma #2: RNA	#Q3
6	9/27	9/29	6. Central dogma #3: Proteins	#Q4
7	10/4		6. Central dogma #3: Proteins	
7		10/6	7. Bioimaging #1: Non-fluorescence-based microscopy	#Q5
8	10/11	10/13	7. Bioimaging #1: Non-fluorescence-based microscopy	
9	10/18	10/20	8. Bioimaging #2: Fluorescence-based microscopy	#Q6
9	10/25		8. Bioimaging #2: Fluorescence-based microscopy	
10		10/27	9. BRAIN initiative	
11	11/1	11/3	10. Diagnosing diseases with light	#Q7
11	11/8		10. Diagnosing diseases with light	
12		11/10	11. Treatment of diseases with light	#Q8
13	11/15	11/17	11. Treatment of diseases with light	
14	11/22	11/24	<i>No class (Thanksgiving break)</i>	
15	11/29		Student presentations #1	
15		12/1	Student presentations #2	
16	12/6		<i>No class (Study day)</i>	
16		12/8	Final exam (4:30 pm – 6:00 pm @ CREOL 102)	