

Syllabus

OSE 4721 Biophotonics

Fall 2020

Location: CREOL 102

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

Number of credits: 3 hours

BlendFlex course: 50% face-to-face & 50% online

Instructor:

Kyu Young Han (Assistant Professor of CREOL)

Email: kyhan@creol.ucf.edu

Office hours:

Tuesday 1:00 pm - 3:00 pm (Zoom or Office: CREOL A334)

Prerequisites:

Not specifically required but OSE 3052 (Foundations of Photonics) would be a helpful course.

Textbook:

None. Lecture notes will be provided.

Other useful texts:

"Introduction to Biophotonics", Paras N. Prasad (2003)

"Biophotonics: Concepts to Applications", Gerd Keiser (2016)

"Physical Biology of the Cell", Rob Phillips (2012)

"Fundamentals of Biomedical Optics", Caroline Boudoux (2017)

Grading:

Quizzes 15% (5% x 3), Homework (10%), Presentation 20%, Midterm 25%, Final exam 30%

Plus and minus grades will be used.

Student presentation:

The students will choose a topic from recent papers, and present it for 10 min.

Course goal:

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.

Course description:

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.

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 (1.5 weeks)
 - 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
 - Fluorescence activated cell sorting
 - 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

Makeup exam policy:

If a student cannot take an exam on the scheduled date, the student must notify the instructor no less than 24 hours before and no more than 48 hours after the scheduled date.

Financial aid statement:

Students' academic activity at the beginning of each course must be documented. In order to document that you began this course, student must complete the academic participation verification question posted on WebCourses no later than week after the first class. Failure to do so will result in a delay in the disbursement of financial aid.