

Syllabus
OSE 4721 Biophotonics
Fall 2023

Location: CREOL 102

Day & Time: Monday, Wednesday; 9:00 am - 10:15 pm

Number of credits: 3

Instructor:

Kyu Young Han (Associate Professor of CREOL)

Email: kyhan@creol.ucf.edu

Office hours:

Monday 10:30 am - 1:00 pm

Prerequisites:

OSE 3052 (Foundations of Photonics)

Textbook:

None. Lecture notes will be provided.

Other useful references:

“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:

Attendance 10%

Presentation 20%

Quizzes 50%

Final exam 20%

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 contemporary biophotonics topics.

Course description:

Biophotonics is a 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 viruses and how to manipulate the brain of mouse with light, etc. No prior knowledge is required to take the course; however, basic knowledge of optics will be helpful.

List of topics

Overview of Biophotonics (0.5 week)

- Biology and Biophotonics
- Medicine/Clinics and Biophotonics

Basics of light-matter interactions in molecules, cells and tissues (1.5 weeks)

- Fundamentals of Biology
- The facts of life (Building blocks, central dogma, components of cells...)
- Biology by the numbers
- Nature of light
- Refraction, reflection, interference, diffraction
- Intensity, phase, polarization, scattering, Raman, fluorescence
- Optical properties of bio-materials

Central dogma #1: DNA & RNA (2 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
- Why is each tissue different from others?
- DNA to RNA transcription
- Count RNA numbers in cells/tissues: qPCR and RNA-FISH

Central dogma #3: Proteins (1.5 weeks)

- Enzyme, antibody
- Circular dichroism spectroscopy to reveal secondary structure of proteins
- Measuring mass of biomolecules with interferometric scattering
- Fluorescence activated cell sorting
- Dissect folding dynamics of proteins: Single molecule FRET
- Drug screening: SPR sensor

Bioimaging #1: Non-fluorescence-based microscopy (1.5 weeks)

- Recap geometrical optics
- Basics of microscopy
- Bright-field/Phase contrast/Dark-field/DIC microscopy
- Raman imaging

Bioimaging #2: Fluorescence-based microscopy (1.5 weeks)

- Fluorophores (Green fluorescent proteins...)
- Epi/Confocal/TIRF microscopy
- Super-resolution fluorescence imaging

BRAIN initiative (0.5 week)

- Interrogate brain with light: Optogenetics
- Deep tissue imaging with multi-photon microscopy & light-sheet microscopy

Diagnosing diseases with light (1.5 weeks)

- Endoscopy
- Optical coherence tomography (OCT): Application to ophthalmology
- Photoacoustic tomography: Application to early cancer detection

Treatment of diseases with light (1.5 week)

- Killing cancer cells with light: Photodynamic therapy

- Tissue engineering with light

Student presentation (1.5 week)

Makeup exam policy:

If a student cannot take a quiz or 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.