

Cursus	Sem.	Type
Biomedical technologies minor	E	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Microtechnics	MA2, MA4	Opt.
Minor in Imaging	E	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Photonics minor	E	Opt.
Physics of living systems minor	E	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	During the semester
Workload	90h
Weeks	14
<b>Hours</b>	<b>3 weekly</b>
Lecture	2 weekly
Exercises	1 weekly
<b>Number of positions</b>	

### Summary

This module serves as an introduction to the area of biophotonics. The approach is multidisciplinary. The course is mainly knowledge-based but students will benefit from the skills learned by carrying out problem solving and by completing the assignment.

### Content

We will focus on aspects following biophotonics aspects: light - biological matter interactions, optical spectroscopies and their applications, lasers in biology and medicine, photobiology, optical imagery, optical biosensors, light as a therapeutic tool, micro-array technology, laser tweezers and emerging biophotonic technologies

### Keywords

absorption, emission, spectral response, reflection fluorescence, scattering, laser, fluorescent labeling

### Learning Prerequisites

#### Required courses

Physics and biology elementary bachelor degree courses  
 Biomicroscopy I  
 Biomicroscopy II

#### Important concepts to start the course

The aims of the course are :

- Understand light-biological matter interaction; such as absorption, emission, spectral response, reflection fluorescence, scattering, etc.
  - Optical sources and detectors
  - Extend this understanding to interaction with cells and tissue highlighting the physical characteristics used in the applications to follow
  - Fluorophore development and functionality, fluorescence microscopy of the cell cycle
  - Show some therapeutic applications of light (Photo-activation of drugs Photo-dynamic therapies Tissue engineering with light)
  - Initiate the students to optical techniques applied to biological materials
  - Give an overview of optical biosensor methods and principles in optogenetics
- Fluorescent labeling and the mechanism of fluorescent resonant energy transfer (FRET), FLIM, FRAP, FCS: applications to biosensors, Raman-based biosensors
- Labelfree: Surface Plasmon resonance (SPR) and dielectric waveguide methods, biosensors based on whispering gallery modes in microresonators
- At the end of the course, the student would have acquired the required knowledge to apprehend the future

biophotonics practical applications.

## Learning Outcomes

By the end of the course, the student must be able to:

- Assess / Evaluate advantages and disadvantages of particular bio photonics technique to solve the problems at the interface of engineering and biology
- Formulate the role of photonics in biology and biomedicine
- Derive the main concepts involved in the interaction of optical radiation with biological materials
- Argue the main applications of biophotonics in particular in the area of imaging and diagnostics
- Solve numerical problems which illustrate the principles of phenomena such as luminescence, absorption and scattering
- Assess / Evaluate bioimaging techniques such as confocal and superresolution microscopies, FRET and FLIM-based imaging
- Demonstrate oral and written communication skills

## Transversal skills

- Write a scientific or technical report.
- Make an oral presentation.
- Manage priorities.

## Assessment methods

During the semester

## Resources

### Bibliography

#### Handouts given during the course

#### Introduction to Biophotonics

Paras N. Prasad, John Wiley & Sons, Hoboken, New Jersey 2003

#### Principles of Fluorescence Spectroscopy

J.R. Lakowicz: 0, 2. Plenum,

#### Optical Biosensors

Ligler, FS. and Rowe Taitt, CA. (2002), Elsevier

#### Biophotonics: Optical Science and Engineering for the 21st Century

Shen, X. and van Wijk, R. (Eds):Springer, Berlin, 2006

#### Advances in Biophotonics

Wilson, B.C., Tuchin, V.V. and Tanev, S. NATO Science Series: Life and Behavioural Sciences, Volume 369, IOS Press, Amsterdam, 2005

Ressources en bibliothèque

- Advances in Biophotonics / Wilson
- Introduction to Biophotonics / Paras
- Biophotonics: Optical Science and Engineering for the 21st Century / Shen
- Optical Biosensors / Ligler
- Principles of Fluorescence Spectroscopy / Lakowicz

## Moodle Link

- <https://go.epfl.ch/BIO-443>

