BIO-443

# Fundamentals of biophotonics

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| Cursus | Sem. | Type |
|---|---|---|
| Bioengineering | MA4 | Opt. |
| Life Sciences Engineering | MA2, MA4 | Opt. |
| Microtechnics | MA2, MA4 | Opt. |
| Photonics minor | E | Opt. |

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


## 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 optogenetcis
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.

## 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