BIO-443

Fundamentals of biophotonics

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Cursus	Sem.	Type
Biomedical technologies minor	E	Opt.
Computational and Quantitative Biology		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
Hours	**3 weekly**
Courses	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
- 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

Ressouces 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

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Moodle Link

• https://go.epfl.ch/BIO-443