

BIOENG-445

**Biomedical optics**

Wagnières Georges

<b>Cursus</b>	<b>Sem.</b>	<b>Type</b>
Biomedical technologies minor	H	Opt.
Life Sciences Engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1, MA3	Opt.
Photonics minor	H	Opt.
Photonics		Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Oral
Workload	90h
Weeks	14
<b>Hours</b>	<b>3 weekly</b>
Courses	2 weekly
Exercises	1 weekly
<b>Number of positions</b>	

**Summary**

This course addresses the principles governing the interactions between light and biological tissue, their optical properties and basic concepts of radiometry. Illustrative diagnostic and therapeutic applications of light in medicine and photobiology will also be described.

**Content****Introduction**

Brief history  
 Introduction to general optics and tissue optics  
 Radiometry and Photometry  
 Light dosimetry  
 Light-tissues interactions  
 Introduction to molecular spectroscopy  
 Photosensitizers

**Principles and techniques**

Absorption, fluorescence and vibrational spectroscopies and imaging.  
 Time-resolved spectroscopy and imaging.  
 Light sources, detectors and optical systems.

**Applications**

Analytical techniques, oxymetry, optical biosensors, Photodetection of early cancers with exogenous and endogenous dyes, Angiography, Phototherapy and Photodynamic therapy, optical coherence tomography.

**Keywords**

Biomedical photonics, tissue optics, light-tissue interactions, photodiagnosis, phototherapy, light dosimetry, dyes, photosensitizers.

**Learning Prerequisites****Important concepts to start the course**

Basic background in biology, chemistry and optics.

**Learning Outcomes**

- Design simple systems used for phototherapy and photodiagnosis.
- Characterize the spectral design of apparatus used in biomedical optics.
- Compute the light dose in biological tissues.
- Identify the optical components to develop an apparatus used in phototherapy.

- Explain the working principles of apparatus used in biomedical optics.
- Model the propagation of light in biological tissues.
- Quantify the light dose in phototherapy.
- Interpret data obtained or published in photomedicine.
- Design simple systems used for phototherapy and photodiagnosis.
- Characterize the spectral design of apparatus used in biomedical optics.
- Compute the light dose in biological tissues.
- Identify the optical components to develop an apparatus used in phototherapy.
- Explain the working principles of apparatus used in biomedical optics.
- Model the propagation of light in biological tissues.
- Quantify the light dose in phototherapy.
- Interpret data obtained or published in photomedicine.

### Transversal skills

- Access and evaluate appropriate sources of information.
- Collect data.
- Make an oral presentation.
- Summarize an article or a technical report.
- Communicate effectively with professionals from other disciplines.

### Teaching methods

Lectures, Exercises, recent literature review papers, classroom discussion + oral presentation.

### Expected student activities

Exercises, lecture of review papers, classroom discussion + oral presentation.

### Assessment methods

Oral exam (1/2) + presentation (3/8) + exercises (1/8).

### Supervision

Office hours	Yes
Assistants	Yes
Forum	No

### Resources

#### Bibliography

- Optics / Hecht EBOOK
- Optics / Hecht
- Optical-Thermal Response of Laser Irradiated Tissue / Welch
- Photosensitisers in Biomedicine / Wainwright
- Optics / Hecht
- Handbook of Photomedicine / Hamblin
- Quantitative Biomedical Optics / Bigio
- Handbook of Biomedical Fluorescence / Mycek
- Principles of Fluorescence Spectroscopy / Lakowicz

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### **Ressources en bibliothèque**

- [Optics / Hecht](#)
- [Optical-Thermal Response of Laser Irradiated Tissue / Welch](#)
- [Handbook of Photomedicine / Hamblin](#)
- [Principles of Fluorescence Spectroscopy / Lakowicz](#)
- [Photosensitisers in Biomedicine / Wainwright](#)
- [Quantitative Biomedical Optics / Bigio](#)
- [Handbook of Biomedical Fluorescence / Mycek](#)

### **Notes/Handbook**

Slides available on Moodle.

### **Moodle Link**

- <https://go.epfl.ch/BIOENG-445>

### **Prerequisite for**

Master. Academic research and R/D activities in the industry of this field