Biophotonics

Academic Year: (2023 / 2024) **Review date: 24/03/2023 15:20:48**

Department assigned to the subject:

Coordinating teacher: ACEDO GALLARDO, PABLO

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The students are expected to have attended the mandatory courses of the Master. It is also highly recommended to have skills in physics, optics, electromagnetism. Basic knowledge of Biology and Chemistry it is also desirable.

OBJECTIVES

To know the fundamentals of light propagation in biological tissues and the methods to obtain their optical characteristics.
To know the fundamentals and different types of interaction between light and tissues.
To know the basics of linear and nonlinear spectroscopic techniques for the characterization of tissues and organs.
To master the fundamental concepts of biological imaging techniques (microscopy, OCT, ...).
To know the basics of optical biosensors and their main fields of application.

DESCRIPTION OF CONTENTS: PROGRAMME

T1. Introduction to Biophotonics. Objectives for the course. Definitions. Types of Light-Tissue and light-cells interaction. The NIR (therapeutic) window. Examples of biomedical applications. (1 Session)

T2. Light-Tissue Interaction. Optical Properties of Tissues with strong (multiple Scattering). Linear (elastic) and non-linear (inelastic) scattering. (1 Session)
T3. Methods to Obtain the Optical Parameters of Tissues. Absorption and scattering coefficients. Photon diffusion coefficient. Short pulse propagation in tissues. Diffuse photon-density waves. (1 session +laboratory session 1)

T4. Light-induced Processes in Tissues. Fluorescence and endogenous and exogenous fluorophores. Non-radiative processes: Photochemical, Thermal, Photoablation¿.) (1 session)

T5. Spectroscopy of Tissues and Cells (I). Linear Spectroscopy: Absorption and dispersion spectroscopy. Continuous-wave, time domain and frequency domain Instruments. Example of real biomedical application instruments. (1 session)

T6. Spectroscopy of Tissues and Cells (II). Non-linear Spectroscopy. Brillouin and Raman Scattering in tissues and cells. Example of real biomedical application instruments. (1 session)

T7. Spectroscopy of Tissues and Cells (III). Fluorescence Spectroscopy. Example of real biomedical application instruments. (1 session)

T8. Bioimaging: An Important medical tool. Transmission Microscopy, Fluorescence Microscopy, Confocal Microscopy, Optical Coherence Tomography. Other Imaging techniques. (1 session)

T9. Photonic Biosensors. Principles of photonic biosensing. Use of Photon Radiation for Non-invasive biomedical instrumentation and medical diagnostic. Example of real biomedical application instruments (1 session+ laboratory session 2)

T10. Advanced concepts for biophotonics. Optogenetics: Interrogating brain with light. Tissue Engineering with Light. Light-Activated Therapy. Laser STweezers and Laser Scissors: Manipulating cells and single molecules. (1 session)

LEARNING ACTIVITIES AND METHODOLOGY

Learning activities
¿ Lectures
¿ Laboratory demonstration and experiments.
¿ Case Studies. The student will team-up in groups to work on selected topics that will be presented and discussed in class.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

¿ Ordinary Call:
¿ Laboratory work (20%)
¿ Case Studies Work (40%).
¿ At the end of the course the students must fill a brief questionnaire (exam) about the topics of the subject (40%).

¿ Extraordinary Call:
¿ The student may follow the continuous evaluation procedure with the same structure as in the ordinary call, or go for a final exam (100% of the final grade).

BASIC BIBLIOGRAPHY

- Gerd Keiser Biophotonics. Concepts to Applications, Springer, 2016

- P.N. Prasad Introduction to Biophotonics, Wiley Interscience, 2003

- V. Tuchin. Tissue Optics. Light Scattering Methods and Instruments for Medical Diagnosis. , SPIE Press. , 2000

ADDITIONAL BIBLIOGRAPHY

- R.B. Northrop. Noninvasive Instrumentation and Measurement in Medical Diagnosis. , CRC Press, 2002