UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Introduction To Biophotonic

2122-3-E3001Q068

Aims

The course "Elements of Biophotonics" has the purpose to introduce the student to the main spectroscopic techniques for investigating biosystems mainly n the UV-.VIS range of the electromagnetic spectrum with a mention to X rays.

The student will learn some features of the most popular biological macromolecules. The principles of the different techniques of investigation will be introduced either from a theoretical and from experimental point of view. The student will be able to understand which kind of information is available by the different techniques when applied to biophysics and nanomedicine.

Contents

Main featrures of the biological macromolecules

Topics about the thermodynamics for biological applications

UV-VIS spectroscopy, in resonance and out-of-resonance mode, elements on fluorescence microscopy

Nanosystems for biomedical applications

Introduction to 3D biological imaging with X rays: from in-vitro to in-vivo.

Detailed program

The players: proteins, nucleic acids, cells, chromophores, nanomaterials. Structures and interactions.

Thermodynamics: Gibbs and Helmholtz free energy. Chemical potential, mass action law. Energy and binding kinetics. Cooperativity effects. The folding-unfolding process-

Spectroscopic Techniques.

Absorption spectroscopy. The Beer-Lambert law. Absorption coefficients. Effects of interaction among chromophores. Characteristic spectra of proteins (alpha helix, beta-sheets, random coils) and DNA. Conformational effects.

Circular dichroism. Principles of CD. Characteristic spectra of proteins (alpha helix, beta-sheets, random coils) and DNA. Conformational effects.

Fluorescence spectroscopy. Spontaneous emission coefficient. Definition of quantum yield, excited state lifetime. Excitation and emission spectra. Dependence from the fluorophore concentration. The intrinsic fluorescence of biomolecules. The most popular fluorescent probes. The class of “Fluorescent Proteins (GFP)”

Mechanisms of fluorescent quenching I: collisional quenching by Stern-Volmer, static quenching and their application to biomolecules.

Mechanisms of fluorescent quenching II: the fluorescent energy transfer mechanism via Foerster theory. Applications.

Solvent effects of fluorescence: bulk effects, Lippert-Mataga equation.

Quasi-elastic light scattering and elements of hydrodynamics. Some applications to biomolecules, molecular size characterization and aggregation studies.

Elements of optical microscopy, confocal and non-linear excitation. Typical microscope setups. Image acquisition. Applications in biophysics (to cells, small organisms, in vivo applications)

Multifunctional nanoparticles for biomedical applications and their interaction with radiation. Targeting mechanisms and cell internalization. Thermal effects in the medical field.

Introduction to 3D biological imaging with X rays: from in-vitro to in-vivo.

Prerequisites

Knowledge of the physics topics acquired in the courses of the first two years of the Bachelor degree in Physics course.

Teaching form

Lessons on classroom with slides. The slides are available on the e-learning platform, together with selected papers to specific topics.

Textbook and teaching resource

Slides loaded on the elearning platform.

Selected papers for further infortmation

Reference textbooks::

1. Webb, Andrew; “Introduction to biomedical imaging”

2. Cantor, Charles R.; Schimmel, Paul R.; "Biophysical chemistry” [Comprende: The conformation of biological macromolecules 1 Techniques for the study of biological structure and function 2 The behavior of biological macromolecules 3]

When needed,new materials is made available and loaded on the e-learning platform.

Semester

I semester

Assessment method

the exam is oral and it will consist in:

1. Brief presentation of a paper published on a scientific journal related to a topic of the course (selected papers are available to the students or it can be chosen independently).

2. As an alternative, a deep insight of a topic of the course can be chosen
3. Open questions of different topics of the course.

NB Part 1 or 2 has a lower weight in the final evaluation of the student.

Office hours

Always by appointment.