UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

# Introduction To Biophotonic

**2425-3-E3001Q068**

## Aims

The course "Elements of Biophotonics" has the purpose to introduce the student to the main spectroscopic techniques for investigating biosystems mainly in the UV-.VIS range of the electromagnetic spectrum.

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

UV-VIS spectroscopy, in resonance and out-of-resonance mode,

Elements on fluorescence microscopy

Elements of thermodynamics for biological applications

Nanosystems for biomedical applications

## Detailed program

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

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)

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

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

## Prerequisites

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

## Teaching form

Traditional lessons ("Didattica erogativa"): Lessons in classroom with slides and blackboard. The slides are available on the e-learning platform, together with selected papers to specific topics.
The recorded lessons are available.

## 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 and it is not sufficient to pass the exam

For Erasmus students: it is possible to take the exam in English.

## Office hours

Always by appointment.

## Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | LIFE ON LAND