UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Chemistry For Biomedical Nanotechnologies

2122-2-F5401Q073

Aims

The student will acquire the theoretical, conceptual and methodological foundations on the preparation, characterization and applications of advanced biomaterials at the nanometer scale. The course includes a part more oriented to the applications of advanced materials for diagnostic and therapeutic applications, and a part more oriented to innovative formulations of advanced 3D materials for tissue engineering applications and prosthetic applications

Contents

The course will be focused on the chemical methodologies to develop nanostructured material for biomedical applications. In particular, chemical approaches to synthesize nanomaterials employing synthetic, natural, and hybrid polymers will be presented. A particular focus will be devoted to the translational potential of bio- and nanomaterials in the development of diagnostic and therapeutic nanostructured tools, implantable medical devices and 3D printed and 3D bioprintable material-based systems. At the end of the course, the student will be able to:

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- Determine the features and the properties of synthetic and natural nanostructured materials for biomedical applications.

- Detect the different performances of biomaterials based on their chemical, structural and biological properties.

- Evaluate the applicability of polymers of various kinds for different biomedical purposes; choose the appropriate

synthetic methodologies useful for the development of nanosystems (nanoparticles or biomaterials) for diagnostic and / or therapeutic purposes.

- Identify the most suitable formulation methodologies based on the target biological system, the pathologies of interest and the use of the medical device / nanoformulation

Detailed program

- the fundamental principles that determine the behavior of biopolymers at the nanoscale;

- methods for preparing nanoparticles, nanostructures, nanofilms, nanopolymers, biopolymers, and in general formulations with tailored structures and morphology;

- methods to characterize nanodimensioned systems, both with spectroscopic methods and with specific microscopy.

- nanoparticles for therapeutic and diagnostic use. Biological problems to be addressed: the fundamental principles of the immune system, biological barriers and corona proteins, reference organs and tissues.

- strategies for controlled drug release, such as targeting nanoparticles on specific tissues and cells. Principles of molecular recognition and biological interactions at the material-tissues interface.

- the functionalization methods of nanomaterials with drugs, diagnostics and molecules proposed for molecular recognition. The chemoselective methods of conjugation.

- the main applications of nanoparticles for biomedical use.

- applications of nanostructured biomaterials capable of mimicking tissues and organs.

- The implantation and application sites of permanent (non-biodegradable) and non-permanent (biodegradable) medical devices

- methods for preparing nanostructured materials in the prosthetic sector and in regenerative medicine

- physico-chemical characterization methodologies

- design and synthetic methods to synthesize natural, synthetic and hybrid materials

- methods of chemoselective functionalization to obtain tissue and organ-specific bio-responsive materials

- cross-linking methods for the covalent stabilization of 3D structures

- methods and strategies of bioactivation of polymeric materials with advanced biological properties

- the development and synthesis strategies of materials in the form of injectable hydrogels, scaffolds, bulks and implantable networks

- manufacturing and formulation processes (solvent casting, lyophilization, modeling and layer-by-leyer etc….)

- the new methodologies of printable polymers and associated strategies: 3D printing and bioprinting, characteristics and classification of printable polymers

- 3D printing and bioprinting: synthetic and characterization methodologies for the development of printable and bioprintable polymers.

- 3D printing and bioprinting: design of prosthetic and tissue 3D models

Prerequisites

NA

Teaching form

Frontal Lectures

Textbook and teaching resource

Slides and Articles

Semester

I Semester

Assessment method

The exam can be taken at the choice of the student in Italian or English and consists of two tests.

The test consists of an oral presentation on topics related to nanoparticles for diagnostic and therapeutic use, biomaterials for tissue engineering applications, biomaterials for prothesis and biomaterials for the development of advanced in vitro cell models.

Individual oral presentations are the subject of open discussion, with questions and contradictions, and the level of knowledge acquired, the autonomy of analysis and judgment, the student's presentation skills, the ability to identify particularly promising advances in a given nanotechnology sector will be checked.

The final grade is expressed in thirtieths with possible “laude”.

Office hours

Any working day by appointment and availability of the teacher.