Biomaterials And Tissue Engineering (AB000008)

1. language

English

2. course contents

Coordinator: Prof. Luigi Ermenegildo Sangaletti

Year Course: 1° Year

Semester: 2^ semester

UFC: 8
Modules and lecturers:

- NANOMATERIALS (AB000071) - 3 cfu - ssd NN
Prof. Luca Gavioli

- PRINCIPLES OF BIOMATERIAL ENGINEERING AND SCAFFOLD DESIGN (AB000074) - 2 cfu – ssd NN

Proff. Simone Sprio, Anna Tampieri

- SCIENCE AT THE NANOSCALE: PHYSICS AND CHEMISTRY OF SURFACES (AB000066) - 3 cfu - ssd FIS/03

Prof. Luigi Ermenegildo Sangaletti

3. BIBLIOGRAPHY

Instructur's notes and presentations will be made available after each lecture. The following textbooks are suggested as a reference:

<Nanomaterials>

Modern Vacuum Physics, A. Chambers, Chapman & Hall/Crc (2005) ISBN 0-8493-2438-6

Atomic Force Microscopy, Bert Voigtländer, NanoScience and Technology Series, Springer (2019) DOI: https://doi.org/10.1007978-3-030-13654-3

Handbook of Sputter Deposition Technology, K. Wasa, I. Kanno, H. Kotera (eds), Elsevier (2012) ISBN: 978-1-4377-3483-6

Scanning Electron Microscopy and X-Ray Microanalysis, J.I. Goldstein et al., Springer (2017), https://doi.org/10.1007/978-1-4939-6676-9

<Principles Of Biomaterial Engineering And Scaffold Design>

A. Tampieri et al. Unconventional, nature-inspired approaches to develop bioceramics for regenerative medicine, ISBN: 9780128222331; doi: 10.1016/B978-0-12-803581-8.12102-2, in: A. Leriche, F.J. Cambier, eds, Reference Module in Materials Science and Materials Engineering, Technical Ceramics and Glasses, Elsevier (2021).

S. Sprio et al. Bioceramics in Regenerative Medicine, ISBN: 9780128222331; doi: 10.1016/B978-0-12-803581-8.12091-0, in: A. Leriche, F.J. Cambier, eds, Reference Module in Materials Science and Materials Engineering, Technical Ceramics and Glasses, Elsevier (2021).

Campodoni et al. Biomineralization process generating hybrid nano- and micro-carriers, in: Focarete ML, Tampieri A, Core-shell nanostructures for drug delivery and theranostics; Challenges, strategies and prospects for novel carrier systems, pp 19-42. ISBN: 9780081021989, Elsevier (2018).

M. Iafisco et al. Hydroxyapatite: From Nanocrystals to Hybrid Nanocomposites for Regenerative Medicine, DOI: 10.1007/978-3-319-09230-0_6-1, in: Antoniac IV, ed: Handbook of Bioceramics and Biocomposites, Handbook of Bioceramics and Biocomposites, pp 119-144, Springer International Publishing (2015).

<Science At The Nanoscale: Physics And Chemistry Of Surfaces>
P. Boisseau, P. Houdy, and M. Lahmani (Eds.) Nanoscience: Nanobiotechnology and Nanobiology; Part II Methods of Nanobiotechnology, Springer (2007)
Jacob N. Israelachvili, Intermolecular and Surface Forces, Third Edition, Elsevier (2011)

4. LEARNING OBJECTIVES

This course will give the students the possibility to acquire and understand major terms and concepts in order to communicate their ideas, proposals, analysis and critical reasoning in an appropriate way. This course will contribute to empower learners giving them very versatile tools that can be applied to many aspects of bio-nano-technology and stem cell growth. They can also be combined with knowledge from other disciplines to provide more accurate or alternative analysis. In detail the course is expected to provide:

Basic knowledge and understanding of (i) materials the nanoscale, (ii) nanomaterials growth and characterization techniques (iii) surfaces and interfaces and their interaction with the environment (iv) and bio-nano materials and nanostructured scaffolds.

The capability of applying knowledge and understanding to biomaterials and stem cell growth on surfaces and nanostructures scaffolds

The capability of making judgements about the suitability of surfaces and nanostructures scaffolds to host stem cells growth.

Communications skills both in terms of oral presentation and written reporting with proper technical terms of problems related to the application of nanomaterials and surfaces stem cells growth.

Learning skills on tackling a problem in stem cells growth from the point of view of nanostructured scaffolds (materials choice in terms of morphology, adhesion properties, biocompatibility).

5. prerequisitES

Bachelor level knowledge of single variable calculus, general chemistry, and classical physics is required.

6. TEACHING METHODS

Knowledge and understanding will be fostered by lectures and class discussions. Power point presentation, web access to proper scientific literature (reports, paper, movies and videos) will provide the basic material to start discussion aimed to enable students to focus on selected applications of nanoscience to stem cell growth and evaluate and judge specific scientific cases proposed during lectures. Discussion will foster communication skills with proper use of scientific and technical terms in English. The lecture materials and their understanding will enable students to autonomously access to further information on the Course topics.

7. OTHER INFORMATIONS

NOTE ON STUDENTS' RESPONSIBILITY

The responsibility for learning falls increasingly on students, as they advance through the course; hence, ultimately, the commitment and the dedication to learn must come from them.

As members of the Università Cattolica S. Cuore learning community, students are expected to respect the intellectual property of course instructors. All course materials presented to students are the copyrighted property of the course instructors and are subject to the following conditions of use:

1) Students may not record nor reproduce lectures or any other classroom activities, unless differently specified by the instructor; however, they may use the recordings for their own course-related purposes only.

2) Students may not reproduce and/or post any course material provided by the instructors online or distribute them without the advance written permission of the course instructor and, if applicable, of any students whose voice or image is included in the recordings.

3) Any students violating the conditions described above may face academic disciplinary sanctions. As members of a learning community, students are expected to respect the time and efforts of their fellow classmates. Therefore, the use of social media and other electronic distractions that can disrupt the concentration of other students in the classroom is NOT allowed.

NOTE ON ACADEMIC INTEGRITY AND CHEATING POLICY

The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University. All students have a right to expect fair and honest evaluation of their work. CHEATING UNDERMINES THIS EXPECTATION AND WILL NOT BE TOLERATED.

Students must avoid the following misconduct behaviors that are considered as cheating:

DO NOT exchange ID badges to collect presence among classmates who cannot attend a lecture.

DO NOT share answers of quizzes during exams.

Any student found by the instructors to be cheating will receive a failing grade for the exam or other graded work, and will be reported to the Course's Coordinator and Instructors' Committee. The instructors may, at their discretion, decide to give a failing grade for the course in severe cases of academic dishonesty.

8. learning verification methods

The final exam consists of two parts:

- *(i) Knowledge and understanding (of basic concepts and applications) will be verified through end-of-module test with multiple answer questions.*
- *(ii) The capability of making judgments, along with communication and learning skills will be evaluated through the presentation of a selected topic of the course (to be defined with the instructor) with a dedicated discussion.*

Grading: test (60%), presentation (40%).

The maximum score can be reached when the student has obtained the maximum from the module test and in case of excellent presentation (clarity, quality of slides, capability to outline the problem and present the basic principles and applications).

9. program

<Nanomaterials>
1.1 An introduction to nanoscale materials: Synthetic and natural nanosystems.
1.2 Physical methods of nanomaterials synthesis. Introduction to vacuum. Magnetron sputtering. Gas phase deposition.
1.3 Measuring nanoscale properties Atomic force microscopy (AFM) Scanning electron microscopy (SEM).

<Principles Of Biomaterial Engineering And Scaffold Design>
2.1 Calcium phosphates and apatites as biomaterials for regenerative medicine
2.2 Biomimetism and "Nature-inspired" concept in Biomaterials Design
2.3 Bio-inspired mineralization process to generate biomimetic bone scaffold
2.4 Graded biomineralization to generate scaffold for regeneration of multifunctional anatomical regions
2.5 Injectable apatitic cements as nanostructured ceramic scaffolds
2.6 Biomorphic transformations for the regeneration of load bearing long bone defect - basic concepts and applications
2.7 Intrinsically antibacterial biomaterials and drug delivery systems
2.8 Superparamagnetic apatites: theory, properties and perspectives

<Science At The Nanoscale: Physics And Chemistry Of Surfaces>
3.1 Introduction to nanoscience. Novel properties driven by dimensionality confinement. Nanoscience @ surfaces. Bio-nanostructures.
3.2 The surface structure. Intermolecular and surface forces. Mechanical and thermal properties.
3.3 Gas and liquid adsorption on surfaces. Adsorption isotherms. Adhesion and wetting. Surface diffusion.
3.4 Special methods for surface investigation. Biosensing.