Universitat Autònoma de Barcelona

2017/2018

Nanotechnology for Diagnostics

Code: 43433
ECTS Credits: 6

Degree	Type	Year	Semester
4314939 Advanced Nanoscience and Nanotechnology	OT	0	1

Contact

Name: Arben Merkoçi Hyka

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Use of languages

Principal working language: english (eng)

Teachers

Anna Roig Serra

Ana Paula Candiota Silveira

Laura Lechuga Gómez

Víctor Franco Puntes

Jordi Aguiló Pedra

Prerequisites

The same admission requirements as the ones to be admited to the Master's Degree:

A degree certificate in **Nanoscience** and **Nanotechnology**, Physics, Chemistry, Geology, Biochemistry, Biotechnology, Telecommunication Electronic Engineering, Materials Engineering, or another degree whose contents fit the profile of this **master's degree**. You may also be admitted to the **master's degree** if you hold an official university degree issued in Spain (in compliance with the legal ordinance prior to the Royal Decree 1393/2007) or in another country, as long as its contents are closely related to the subjects offered in the **master's degree**.

- Good level of English, equivalent to Level B2 of the Common European Framework of Reference for Languages.

Objectives and Contextualisation

Learning theoretical and practical aspects of the main principles of the synthesis and characterisation of nanomaterials including examples of their integration into systems with interest for clinical, food and environmental diagnostics.

Skills

- Analyse research results to obtain new products or processes, assessing their industrial and commercial viability with a view to transferring them to society
- Analyse the benefits of nanotechnology products, within one's specialisation, and understand their origins at a basic level

- Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
- Continue the learning process, to a large extent autonomously
- Designing and applying nanomaterials and nanoparticles in diagnosis and therapy in biological systems. (specialty nanobiotechnology)
- Identify and distinguish the synthesis/manufacture techniques for nanomaterials and nanodevices typically adopted in one's specialisation.
- Identify the characterisation and analysis techniques typically adopted in nanotechnology and know the principles behind these, within one's specialisation.
- Seek out information in the scientific literature using appropriate channels, and use this information to formulate and contextualise a research topic.
- Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

Learning outcomes

1. Analyse research results to obtain new products or processes, assessing their industrial and commercial viability with a view to transferring them to society.
2. Classify electrochemical bioanalysis techniques based on nanomaterials.
3. Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
4. Continue the learning process, to a large extent autonomously
5. Describe the basic aspects of using nanoparticles to obtain images for diagnosis.
6. Describe the main contaminants in foods, water and the environment.
7. Identify optical bioanalysis techniques based on nanomaterials.
8. Identify requisites for using nanomaterials in imaging, nanoparticle introduction techniques, and image reading/processing.
9. Identify the basic principles of the MRI technique and choose the appropriate contrast agent.
10. Identify the principal techniques for synthesising and functionalising nanomaterials for use in diagnosis.
11. Seek out information in the scientific literature using appropriate channels, and use this information to formulate and contextualise a research topic.
12. Show expertise in connection routes between nanomaterials and biomolecules as antibodies, DNA, etc.
13. Show expertise in using scientific terminology and explaining research results in the context of scientific production, in order to understand and interact effectively with other professionals.
14. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
15. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

Content

Topics:

o Nanomaterials (nanoparticles, nanowires, nanotubes, graphene etc.) with interest for diagnostics. Main methods of synthesis and characterisation.

o Chemical and biological functionalization of nanomaterials with bioreceptors (ex. antibodies, DNA etc.) and other synthetic compounds.

o Generals aspects on clinical (in-vivo, in-vitro) (ex. DNA, proteins, cells etc.), environmental (ex. pollutants) and food diagnostics. Conventional analytical and point-of-care technologies and their relation with nanotechnology and nanomaterials.

o Imaging based on nanomaterials and applications in clinical diagnostics. Use of magnetic nanoparticles (NP), gold NPs, quantum dots (QD) and other nanomaterials. Imaging techniques, MRI. Contrast agents.

o Design and application of nanobiosensors (optical, electrochemical, magnetic etc.), lateral flow and lab-on-a-chip with interest for diagnostics (clinical, environmental, security etc.).

With detail:

Ana Paula Candiota (7 hours) Introduction to diagnostics: in vivo/in vitro modalities, advantages of non-invasive techniques. General concepts of biomarkers. Use of biomarkers in diagnosis and prognosis. Limiting factors due to timing and concentration. Relevance of the preclinical models in preliminary studies. Main types of preclinical models available. Ethical aspects. Specific aspects related to nanoparticle in vivo studies: advantages of previous intermediate assays (e.g. ex vivo studies); solubility/stability of nanoparticles prior to administration; functionalization; presence of contaminants and its consequences in vivo; interaction with cellular receptors; ability to reach the target organ. In vivo biomarkers: multiparametric analysis with MRS/MRSI in animal models.

Victor Puntes (6 hours) Nanoparticles (synthesis and characterisation); Gold nanoparticles and quantum dots; general properties, characterization methods; Modification of nanoparticles and quantum dots with antibodies, peptides etc.;

Laboratory demonstration of gold nanoparticles and quantum dots synthesis and modification.
Location: Inorganic nanoparticles Lab at ICN2 (Bellaterra, UAB).

Laura Lechuga (6 hours) Definition of biosensor devices; Main characteristics of biosensors; Classification and Applications; Overview of the different types of biosensors; Introduction to optical biosensors; Evanescent wave sensing principle; Surface Plasmon Resonance (SPR) biosensor; Photonic sensors based on waveguides (Grating coupler waveguide sensors, Microring resonator sensors; Integrated Interferometers sensors, photonic crystals, silicon wires,...);

Laboratory demonstration of optical biosensors including SPR and integrated optical sensors.
Location: Nanobiosensors & Bioanalytical Applications Lab at ICN2 (Bellaterra, UAB).

Arben Merkoçi (6 hours); Nanoparticles, quantum dots and graphene applications in biosensing systems; General properties, modifications and integration into diagnostic devices; Applications examples for DNA, protein and cancer cells diagnostics using electrochemical (voltammetry, electrochemical stripping etc.) methods.
Laboratory demonstration of an electrochemical and lateral flow based biosensing system for proteins detection. Nanoparticles preparation, modification and typical biosensing procedure.
Location: Nanobioelectronics & Biosensors Lab at ICN2 (Bellaterra, UAB).

Anna Roig ICMAB (6 hours); In-vivo medical imaging: Fundamentals to diagnostics imaging modalities (PET, SPECT, MRI, Fluorescence, Bioluminiscence, Ultrasounds). Nanomaterials as contrast agents. Multimodal imaging probes. Cell tracking with imaging techniques

Jordi Aguilo (7 hours); Introduction on Lab-on-a-chip (LOC); LOC fabrication; Nano/microfabrication tools for LOC; Characterisations; Applications in biosensing.

Methodology

Lectures

Oral presentation of works

Preparation of papers

Personal study

Reading articles / reports of interest

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	37.5	1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15
Type: Supervised			
Oral presentations of works	10	0.4	1, 2, 3, 4, 5, 6, 11, 12, 13, 14, 15
Type: Autonomous			
Personal Study	50	2	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15
Reading articles / reports of interest	40	1.6	1, 3, 4, 7, 8, 9, 10, 11, 14

Evaluation

10-30% Assistance and class participation.

20-70% Oral presentation and Reports.

20-70% Exam.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Assistance and participation	10-30%	0	0	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
Exam	20-70%	2.5	0.1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
Oral presentations and Reports	20-70%	10	0.4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Bibliography

Important books and articles will be mentioned during the lectures. All optional.