Universitat Autònoma de Barcelona

2023/2024

Nanotechnology in Biomedicine

Code: 103272
ECTS Credits: 6

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	OT	4	0

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Teachers

Anna Roig Serra

Leonor Ventosa Rull

Prerequisites

None specific

Objectives and Contextualisation

To give students a perspective on what materials and substances are used in nanotechnology applied to Biomedicine, what are the synthetic protocols, and the main tools for their characterization. Likewise, modification strategies will be considered to make these nanomaterials biocompatible, vectorize their transport, and, if necessary, control their internalization in the cells, and their biodistribution in animal models. We will also consider possible toxicity problems and some examples of the biomedical applications of these nanomaterials.

Competences

- Adapt to new situations.
- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Be ethically committed.
- Communicate clearly in English.
- Communicate orally and in writing in one's own language.

- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Operate with a certain degree of autonomy.
- Perform correct evaluations of the environmental and socioeconomic impact of chemicals and nanomaterials.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Show motivation for quality.
- Show sensitivity for environmental issues.
- Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Learning Outcomes

1. Adapt to new situations.
2. Be ethically committed.
3. Communicate clearly in English.
4. Communicate orally and in writing in one's own language.
5. Correctly use the necessary computer tools to interpret and expose the results obtained.
6. Draft reports on biology and bionanotechnology in English.
7. Evaluate the risks for the human health of nanomaterials used in bionanotechnology.
8. Identify the scientific bases and applications of tissue engineering and of nanosystems for release of drugs.
9. Interpret specific scientific and technical studies of nanobiomedicine
10. Learn autonomously.
11. Manage the organisation and planning of tasks.
12. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
13. Operate with a certain degree of autonomy.
14. Propose creative ideas and solutions.
15. Reason in a critical manner
16. Recognise image acquisition systems and the nanotechnological analytical systems of medical interest.
17. Recognise problems of interest in the field of nanobiomedicine and make bibliographic studies to find solutions
18. Recognise the English terms employed in biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
19. Resolve problems and make decisions.
20. Show motivation for quality.
21. Show sensitivity for environmental issues.
22. Understand texts and bibliographies in English on biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
23. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

Topic1. Basic concepts in nanomedicine: nanoparticles in biological environments, biocompatibility, stability, and aggregation. Functionalization of nanomaterials and their application to nanomedicine.
Topic 2. Nanomaterial administration routes, advantages and disadvantages, and obstacles to overcome. Cellular traffic. Biological barriers. Smart nanomaterials: applications in therapy and diagnostics. Theranostic nanomaterials. Nanomaterials and the immune response.

Topic 3. Biosensors and integrated devices of medical interest. Biosensors: definition, characteristics, classification, and applications. Bioreceptors and analytical nanodevices.

Topic 4. Nanoscience and nanotechnology in medical imaging techniques. Basic fundamentals of the different medical imaging techniques: Ultrasound, Magnetic Resonance Imaging, Computerized Tomography, Positron Emission Tomography, Contrast Agents. Comparison of different types of images. Future trends.

Topic 5. Nanosystems of transport and selective release of drugs. General concepts Relevant physical-chemical characteristics of "drug delivery" systems. Nanotransporters used in "drug delivery". Challenges in the synthesis of nanomedicines for "drug delivery". Examples of products in the clinical phase and in the market.

Topic 6. Tissue engineering applied to regenerative medicine. Nanofibres and "nanoscaffolds" for regeneration of the nervous and cardiovascular tissue. Nanomaterials for implants. Nanotubes as "scaffolds" for bone and joint growth. Nanotechnology in wound repair.

Topic 7. Nanosurgery. Nanotechnology for hemostasis during surgery. Catheters as biosensors for minimally invasive surgery. Nanoscale surgery, Nanorobotic surgery.

Topic 8. Nanotoxicology. Toxicity of nanoparticles. Blood compatibility. Routes of exposure. Accumulation and deposits of nanoparticles in tissues. Measures to reduce the toxicity of nanoparticles. Environmental effects of nanoparticles. FDA and EMA regulation for nanobiotechnology products.

Methodology

The subject consists of theory master classes, problem classes and practical laboratory classes.
15 minutes of class will be devoted to answering the UAB institutional surveys.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classes of problems or practices	18	0.72	1, 7, 11, 9, 21, 12, 13, 17, 6, 19, 23
Master classes	34	1.36	10, 3, 20, 8, 2, 15, 16, 18
Type: Supervised			
Tutorial	8	0.32	22, 20, 12, 13, 15, 6, 19, 5
Type: Autonomous			

Individual study	61.5	2.46	10, 22, 3, 11, 8, 9, 12, 13, 15, 18, 19, 23
Resolution of practical cases and problems	22.5	0.9	1, 22, 4, 9, 2, 14, 15, 17, 6, 19, 23, 5

Assessment

This subject will not apply the single evaluation protocol.
Coursework evaluation: 30% of the total in three different work delivers, written exam 70% of the total divided into two partial exams.

Exams: There will be two exams with more or less half of the subject matter in each one. The final mark will be the average of the two partial ones. There is a retaken exam to recover the partial ones.

Assessment of work during the course: Three tasks will be carried out during the course. They can be bibliographic searches, presentations of seminars, data interpretation of works, etc. According to the teacher, they can be individual or group activities to be delivered in printed form or through the virtual campus.

The minimum mark to pass will be 5 out of 10. The average of the exams will be done only with those grades that are > = 4.0 .
To participate in the retake exam, the students must have been previously evaluated in a set of activities whose weight equals to a minimum of two-thirds of the total grade of the subject, and a grade of at least 3.5.
The retake (final) exam will include the theoretical contents and that will be worth up to 70% of the final grade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Theory classes	70	4	0.16	10, 7, 22, 4, 20, 11, 8, 9, 2, 13, 14, 15, 16, 18, 17, 19, 5
Work delivers	30	2	0.08	1, 10, 22, 3, 4, 11, 2, 21, 12, 14, 15, 6, 19, 23

Bibliography

Books of reference:

1- Nanomedicine. An Introductory Text Book. Rob Burgess. Plan Sanford Publishing 2012.

2- Nanoparticles in translational science and medicine. In "Progress in Molecular Biology and Translational Science and Medicine" Vol. 104. Elsevier, Amsterdam, 2011.

3- Applications of Targeted Nano drugs and Delivery systems. Elsevier 2018.

4- Principles of Nanomedicine. Taylor and Francis ebooks. 2019.

Software

None