Universitat Autònoma de Barcelona

2022/2023

Nanobiotechnology

Code: 100904
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	OT	4	2

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: No

Some groups entirely in Spanish: No

Other comments on languages

Classroom practices and chapters 1 to 3 will be taught in English. All contributions submitted for evaluation in English language will produce a bonus. This bonus will multiply the numerical grade obtained by a factor between 1 (minimum) and 1.1 (maximum)

Teachers

Carles Arus Caralto

Julia Lorenzo Rivera

Prerequisites

No specific requirements. Still, it is advisable that exchange students have succesfully completed already 2 full academic years at their originating institution. Most reference literature is in the English language, which is also used in the figures projected in theory classes. Furthermore, oral communication in English will be used when the student addresses the teacher in this language.

Objectives and Contextualisation

To provide students with an adequate perspective of materials used in nanobiotechnology, their major synthesis protocols and the main methodologies available to characterize them. Strategies to increase the biocompatibility of nanomaterials and to vectorialize their transport to cells and inside cells will be considered. Finally, toxicity related possible problems and characteristic examples of the applications of such nanomaterials in living systems will be analysed.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Be able to self-evaluate.
- Collaborate with other work colleagues.

- Define the structure and function of proteins and describe the biochemical and molecular bases of their folding, intracellular traffic, post-translational modification and replacement.
- Design experiments and understand the limitations of experimental approaches.
- Integrate scientific and technological knowledge.
- Interpret experimental results and identify consistent and inconsistent elements.
- Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
- Manage information and the organisation and planning of work.
- Read specialised texts both in English and one's own language.
- Stay abreast of new knowledge of the structure, organisation, expression, regulation and evolution of genes in living beings.
- Take responsibility for one's own learning after receiving general instructions.
- Think in an integrated manner and approach problems from different perspectives.
- Understand the language and proposals of other specialists.
- Use analytical methodologies for assaying the biological activity of cellular components, especially enzymes, both in vitro and in vivo.
- Use the basics of mathematics, physics and chemistry that are required to understand, develop and evaluate the chemical procedures of living matter.

Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Apply spectroscopic and microscopic techniques to localise specific molecules in cells and determine enzyme activity.
3. Be able to self-evaluate.
4. Collaborate with other work colleagues.
5. Describe in detail the biophysical methods used to reveal the dynamic structure and properties of DNA and chromatin.
6. Design experiments and understand the limitations of experimental approaches.
7. Explain in detail the biophysical methods used to reveal the dynamic structure and properties of proteins.
8. Identify fundamental issues in present-day biophysics.
9. Interpret experimental results and identify consistent and inconsistent elements.
10. Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
11. Manage information and the organisation and planning of work.
12. Read specialised texts both in English and one's own language.
13. Review the contributions made by biochemistry and molecular biology to the construction of today's nanotechnology.
14. Take responsibility for one's own learning after receiving general instructions.
15. Think in an integrated manner and approach problems from different perspectives.
16. Understand the language and proposals of other specialists.

Content

Chapter 1. (in English) Introduction. Concept of Nano(bio)tecnology. Nanomaterials/nanoparticles/nanorobots. Nanometrology. Major methodologies for characterizing nanoparticles and nanomaterials. Nanofabrication. Interaction of nanomaterials with tissues.

Chapter 2. (in English) Major methodologies for characterization of nanoparticles and nanomaterials. Size, size range and concentration. Zeta potential. Electron Microscopy. Atomic force microscopy. Force spectrometry and cantilever sensors. Nanometrology and nanomanipulation. Optical tweezers. Other.

Chapter 3. (in English) Types of nanomaterials. Liposomes. Inorganic core nanoparticles. Organic core nanoparticles. Protein-based nanoparticles. Carbon-based nanotubes and graphene.

Chapter 4. Functionalization of nanomaterials to improve desired features: biocompatibility, substance transport, vectorialization, selective release (cell internalization, sub-cellular targeting), in vivo visualization of nanostructures, generation of biosensors and analytical nanodevices.

Chapter 5. Nanofabrication. Starting nanomaterials (nanoparticles, nanoplates, graphene-based materials). Nanofabrication: bulk (hard/top down), soft, atom by atom selective (pick and place).

Chapter 6. Aplications of Nano(bio)technology to: personalized medicine (diagnostic and therapy, tissue engineering, biodistribution, nanotoxicology). Other applications.

Methodology

Theory and guided problem-solving classes. Emphasis will be placed on the learning performance of students. Such learning performance will be actively fostered by teachers by providing gradings for the homework and problem-solving tasks performed by students (see evaluation strategy section). Laboratory work (3 sessions) will be performed in 2-3 people groups.

15 minutes of a class will be dedicated to answer the institutional surveys of the UAB

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			
Laboratory work	12	0.48	2, 4, 6, 16, 11, 9, 12, 15
Problems based teaching	13	0.52	2, 6, 16, 9, 12, 15, 13, 14
Theory classes	26	1.04	2, 5, 16, 7, 8, 13
Type: Supervised			
Homework delivery and associated interaction through "Campus Virtual"	14	0.56	4, 11, 12, 15, 14
Tutor supervision	2	0.08	16, 3
Type: Autonomous			
Information retrieval, study, processing of gathered information and electronic delivery of supervised homework through "Campus Virtual"	46.5	1.86	4, 16, 11, 8, 9, 12, 15, 13, 14, 3
Solving problems	10	0.4	2, 4, 16, 9, 12, 15, 13, 14
Studying for exams	10	0.4	16, 11, 8, 9,

			12, 15, 13
Writing the laboratory work report	6	0.24	4, 16, 9, 12, 14

Assessment

All contributions submitted for evaluation in English language will produce a bonus. This bonus will multiply the numerical grade obtained by a factor between 1 (minimum) and 1.1 (maximum).

- The percentage contribution to the global evaluation will be: *50% supervised participative homework* and problem solving evaluation minimum of 3 different evaluation items, 10% Laboratory work evaluation and delivery of the lab work report, 40 % partial exams (two).

- Exams: Written exams with short questions and/or problems to solve, with unlimited offline access to course related information. Internet access authorization during the exam will vary in different partial exams (acces allowed for first partial, but not allowed fo 2nd partial). The first partial will be after chapter 3, and the second one, after chapter 6. Final exam grade will be the mean of the two partial exams.

- Continuous work performance evaluation. There will be a minimum of 3 homework reports to be delivered during the course. Such homework may be of the type of: problem solving, publication data interpretation, literature search, seminar delivery, etc. Every teacher in charge will propose the homework subject through the "Campus Virtual" interactive tools. In case written deliveries are requested, both electronic and printed submission within the allocated time frame will be mandatory. Homework may be individual or in small groups, according to the teacher instructions in each instance.

- Revision of grades. A revision date and time frame will be announced after each written partial exam. Furthermore, grades for other course work will appear periodically all along the course at the "Campus Virtual". There will be at least 3 time frames for revision offered during the course. Day and time frame for grade revision will be duly advertised at "Campus Virtual" at least 48 hours prior to the starting revision time, and also at class time.

- As for thegrading strategy,all homework and supervised work handed in for evaluation (3 items minimum) will be considered individual items contributing the global evaluation section of the course (50% of the total grading).

- Students not able to attend an evaluation exam due to relevant conditions (illness, family death, accident) and deliver valid proof of such condition to the teacher/degree Coordinator, will be allowed to perform the missing evaluation at a different date. The degree coordinator will oversee this in case of need to secure an adequate date for performing the additional evaluation.

- To be able to attend the laboratory work sessions the student should provide proof of successful evaluation of lab security and biosecurity conditions available through "Campus Virtual". Furthermore, he/she should be aware and accept the rules for access and work at the laboratories of the Faculty of Biosciences.

- Retake process description. To be eventually eligible for the application of the retake process for final grading, the student should have been evaluated in a set of activities equalling at least two thirds of the final score of the course or module. Thus, the student will be graded as "*No Avaluable*" (Not Assessable) if the weighting of all conducted evaluation activities, before application of the retake evaluation derived grades, is less than 67% of the final score. Any grade obtained in the activities identified as "retake activities" will substitute the grade obtained in the previous activity that the retake activity is substituting, independently of the previous grade being lower or higher than the retake grade. The retake session will be applied to grade producing activities equivalent at least to 50% of the final score. Namely, the specific items involved in the retake process will substitute the grade derived from exams 1 and 2 (40% of the global grade) and 1/6 of the grade derived from the participative and lab work (10% of the global grade, problems+homework+lab work evaluation). The retake activity will allow access to all course-related materials during the retake activity, including the Internet. To avoid unnecessary printing of grading materials or reserving spaces for retake sessions not actually needed, there will be a 48 hours period prior to the retake activity for students to declare

their interest in attending the retake session. Only students having declared interest in attending the retake session through the Campus Virtual before the 48 hours deadline will be admitted to the retake activity. In case no student requests to participate, the retake session will be canceled.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Homework delivery	50%	6	0.24	4, 5, 16, 7, 11, 8, 10, 12, 15, 13, 14, 3
Laboratory work evaluation and delivery of the lab work report	10%	0.5	0.02	2, 4, 6, 16, 9
Partial exams	40%	4	0.16	1, 16, 9, 12, 15, 13

Bibliography

Reference Books

1. Principles of Nanomedicine. Ed. Sourav Bhattacharjee, 2019, Jenny Stanford Publishing.

2. An Introductory Textbook. Rob Burgess, 2012, Pan Stanford Publishing.

3. Nanoparticles in translational science and medicine. Ed Antoni Villaverde, in "Progress in Molecular Biology and Translational Science and Medicine" Vol. 104, 2011, Elsevier, Amsterdam.

4. Nanobiotechnology. Eds. Christof Niemeyer and Chad Mirkin, 2004, Wiley-VCH.

5. Nanobiotechnology II. Eds. Chad Mirkin and Christof Niemeyer, 2007, Wiley-VCH.

6. Bionanotechnology. Concepts and applications, by Ljiljana Fruk and Antonina Kerbs. Cambridge University Press 2021.

Software

None