



## Teaching Guide

Teaching Guide				
Identifying Data			2023/24	
Subject (*)	Nanotechnology in Medicine		Code	610G04037
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Optional	4.5
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Bioloxía			
Coordinador	Fafián Labora, Juan Antonio	E-mail	juan.labora@udc.es	
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Web				
General description	The aim is to provide students with an overview of the materials, molecules, biomolecules and technologies used in nanotechnology with direct application to medicine, as well as the preparation protocols and the main characterisation tools used. We will also consider modification strategies to make these nanomaterials biocompatible, vectorise their transport and, if necessary, control their internalisation in cells, and their biodistribution in animal models for use in tissue nanotechnology. We will also consider possible toxicity issues and some examples of biological applications of these materials. We will also learn about the ethical and legal aspects of the use of nanotechnology in the field of medicine.			

## Study programme competences

Code	Study programme competences
A1	CE1 - Comprender los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología.
A2	CE2 - Aplicar los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología a la resolución de problemas de naturaleza cuantitativa o cualitativa.
A9	CE9 - Evaluar correctamente los riesgos sanitarios y de impacto ambiental asociados a la Nanociencia y la Nanotecnología.
A10	CE10 - Comprender la legislación en el ámbito del conocimiento y la aplicación de la Nanociencia y Nanotecnología. Aplicar principios éticos en este marco.
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
B4	CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B11	CG6 - Comportarse con ética y responsabilidad social como ciudadano/a y como profesional.
B12	CG7 - Comunicarse de manera efectiva en un entorno de trabajo.
C4	CT4 - Desarrollarse para el ejercicio de una ciudadanía respetuosa con la cultura democrática, los derechos humanos y la perspectiva de género
C5	CT5 - Entender la importancia de la cultura emprendedora y conocer los medios al alcance de las personas emprendedoras
C6	CT6 - Adquirir habilidades para la vida y hábitos, rutinas y estilos de vida saludables
C7	CT7 - Desarrollar la capacidad de trabajar en equipos interdisciplinares o transdisciplinares, para ofrecer propuestas que contribuyan a un desarrollo sostenible ambiental, económico, político y social.
C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad

## Learning outcomes



Learning outcomes	Study programme competences		
Synthesise, prepare and characterise biomaterials for use in nanomedicine	A1 A2 A9	B3 B4 B8 B12	C5 C7 C8
To know the structural characteristics of materials and the main techniques for their identification and characterisation	A1 A2 A9	B3 B4 B12	C5 C7 C8
Operate laboratory instrumentation and equipment for chemical, physical and biological experiments at the nanoscale	A1 A2 A9	B3 B4 B8 B12	C5 C7 C8
Interpret data obtained from experimental data using specific software tools	A1 A2 A9	B3 B4 B8 B12	C5 C7 C8
Understand and evaluate legislation in the field of knowledge and application of Nanoscience and Nanotechnology in medicine. Apply ethical principles in this framework	A1 A2 A9 A10	B3 B4 B11 B12	C4 C5 C6 C7 C8

Contents	
Topic	Sub-topic
Topic 1. Concept of nanomedicine	Nanoparticles in biological environments, biocompatibility, stability and aggregation. Functionalisation of nanomaterials and their application to nanomedicine. Routes of administration of nanomaterials, advances and drawbacks and obstacles to overcome. Cellular traffic. Biological barriers. Smart nanomaterials: applications in therapy and diagnostics... Nanomaterials and immune response
Topic 2. Nanodiagnosis in vitro: nanosensors and integrated devices	Nanodiagnosis: Introduction to medical diagnosis. Biosensors and integrated devices of medical interest. Biosensors: definition, characteristics and applications. Bioreceptors and analytical nanodevices. Biomarkers. Diagnostic techniques based on immunoassay (Dot blot, Western blot, ELISA, flow cytometry, laminar flow). Diagnostic techniques based on plasmonic sensors (SERS, SEF, FRET). Diagnostic techniques based on microfluidic platforms (lab on a chip)
Topic 3. Nanodiagnosis in vivo: diagnostic imaging	Basic fundamentals of the different medical imaging techniques: Ultrasound, Magnetic Resonance Imaging, Computed Tomography. Positron Emission Tomography, Contrast Agents. Comparison of the different imaging modalities.
Topic 4. Tissue nanotechnology. Nanofabrication and characterisation of scaffolds	Gels and self-assembled systems. Composites. Supercritical fluids and aerogels. Electrospinning and bioprinting. Tissue engineering. Introduction to regenerative medicine: regeneration processes, fibrosis, scaffolding vs. implant. Cell modulation through biomechanics, cell adhesion, roughness and nanostructure. Active substance delivery systems with application in regenerative medicine: conventional drug delivery systems, sustained release of proteins, gene therapies.
Topic 5. Nanosurgery	Nanotechnology for haemostasis during surgery. Catheters with biosensors for minimally invasive surgery. Nanoscale surgery. Nanorobotics for surgery.



Topic 6. Nanotoxicology	Topic 6. Nanotoxicology. Toxicity of nanoparticles. Blood compatibility. Routes of exposure. Accumulation and deposition of nanoparticles in tissues. Measures to reduce nanoparticle toxicity. Environmental effects of nanoparticles. FDA e EMA regulation of nanobiotechnology products.
Topic 7. Ethical and legal aspects	Ethical and legal aspects in Nanotechnology in Medicine

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Laboratory practice	A9 B3 B4 B8 B11 B12 C7	10	20	30
Supervised projects	A2 A10 B3 B4 B8 B11 B12 C4 C7	7	14	21
Mixed objective/subjective test	A1 A2 A9 A10 B3 B8 C8	5.5	0	5.5
Guest lecture / keynote speech	A1 A2 A9 A10 C5 C6 C8	18	36	54
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Laboratory practice	Development of techniques of current use in nanoscience research in medicine, complementing the knowledge imparted in the master session.
Supervised projects	Final activity reflecting the theoretical and methodological mastery of the subject.
Mixed objective/subjective test	Mixed test used for the assessment of learning.
Guest lecture / keynote speech	The topics of the subject will be taught by the lecturers with the help of audiovisual aids. The relevant documentation will be made available to students on the Virtual Campus.

Personalized attention	
Methodologies	Description
Supervised projects	Laboratory practice. For students, personalised tutorials will be provided, focusing on guidance for problem solving, resolving doubts and clarifications. This personalised attention will be carried out throughout the course and upon request of the students.  Supervised projects. Students may also request personalised direct and/or virtual tutorials and resolve specific doubts by e-mail.
Laboratory practice	

Assessment			
Methodologies	Competencies	Description	Qualification
Mixed objective/subjective test	A1 A2 A9 A10 B3 B8 C8	Proba que pode integrar preguntas tipo de probas de ensaio e preguntas tipo de probas obxectivas.  En canto a preguntas de ensaio, recolle preguntas abertas de desenvolvemento. Ademais, en canto preguntas obxectivas, pode combinar preguntas de resposta múltiple, de ordenación, de resposta breve, de discriminación, de completar e/o de asociación. múltiple.	60
Supervised projects	A2 A10 B3 B4 B8 B11 B12 C4 C7	O alumnado levará a cabo un traballo en grupos ou individualmente e presentación oral relacionados con algún tema da materia.	25



Laboratory practice	A9 B3 B4 B8 B11 B12 C7	As prácticas de laboratorio considéranse unha actividade de asistencia obrigatoria para superar a materia. A avaliación dos coñecementos adquiridos avaliarase por unha memoria de prácticas desenvolvida polo alumnado.	15
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## Assessment comments

A galego portugués inglés francés catalán vocabulario administrativo vocabulario xurídico vocabulario xeral LABORATORY PRACTICES are mandatory. Absence from practicals must be duly justified in order to pass the subject. First and second chance: In order to pass the subject a 5 must be obtained in the mixed test. If the qualification resulting from the sum of all the evaluable activities is equal to or higher than 5, but the indicated requirement is not met, the qualification will be 4.0 (fail). The mixed test may consist of any of the following and/or a combination of several: Essay questions: open-ended essay questions, multiple-choice questions (one or more of the answers may be true), ranking questions, short answer questions, discrimination questions, fill-in-the-blank questions, association questions. It is considered as Not Presented (NP) when the student does not take the test in the official evaluation period. Plagiarism and the use of non-original material, including material obtained from the internet, without express indication of its origin and, if applicable, the permission of its author, will be graded with a fail (0.0) in the activity. If a student copies during an exam, this will result in a fail (0.0) in the subject in the corresponding exam session. Grading system: Numerical from 0 to 10, with 10 being the highest mark and 5 a pass. The qualification system will be expressed by numerical qualification in accordance with the provisions of art. 5 of Royal Decree 1125/2003 of 5 September (BOE 18 September), which establishes the European credit system and the qualification system for official university degrees valid throughout the national territory. Grading system: 0-4.9=Suspense, 5-6.9=Aprobado, 7-8.9=Notable, 9-10=Sobresaliente, 9-10 Matricula de Honor (Graciable). Honours will be awarded preferentially to students who achieve a grade equal to or higher than 9 at the first opportunity (January). In the case of part-time students who are exempt from attendance, additional measures may be adopted to enable them to pass the subject, such as flexibility in the deadline for submitting assignments, flexibility in the timetable for practicals or the performance of a global test to assess the learning outcomes. Fraudulent performance in the assessment tests or activities, once verified, will directly lead to a failing grade of "0" in the subject at the corresponding time.

## Sources of information

<b>Basic</b>	<ul style="list-style-type: none"> <li>- Yi Ge, Songjun Li, Shenqi Wang, Richard Moore (2014). Nanomedicine: Principles and Perspectives &amp;quot; Nanostructure Science and Technology&amp;quot;. Springer</li> <li>- A Villaverde (2011). Nanoparticles in translational science and medicine. &amp;quot;Progress in Molecular Biology and Translational Science&amp;quot;. Elsevier</li> <li>- Dimitrios P. Nikolelis and Georgia-Paraskevi Nikoleli (2018). Nanotechnology and biosensors. Elsevier</li> <li>- Alexandru Mihai Grumezescu (2017). Nano- and Microscale Drug Delivery Systems. &amp;quot;Design and Fabrication&amp;quot;. Elsevier</li> </ul>
<b>Complementary</b>	<ul style="list-style-type: none"> <li>- (). Links to the European Technology Platform for Nanomedicine. <a href="http://www.etp-nanomedicine.eu/public">http://www.etp-nanomedicine.eu/public</a>.</li> <li>- (). Center for Cancer Nanotechnology Excellence and Translation, Stanford University. <a href="http://nano.cancer.gov/action/programs/stanford/">http://nano.cancer.gov/action/programs/stanford/</a></li> <li>- (). The International Association of Nanotechnology . <a href="http://www.ianano.org">http://www.ianano.org</a></li> </ul>

## Recommendations

### Subjects that it is recommended to have taken before

Techniques of Characterisation of Nanomaterials 2/610G04030  
 Techniques of Characterisation of Nanomaterials 1/610G04025  
 Synthesis and Preparation of Nanomaterials/610G04020  
 Molecular and Metabolic Biochemistry/610G04023  
 Cell Biology/610G04003  
 Integrated Basic Laboratory/610G04004

### Subjects that are recommended to be taken simultaneously

Molecular Machines/610G04036

### Subjects that continue the syllabus

Nanotechnology in Pharmacy/610G04043  
 Nanofabrication/610G04040



## Other comments

Recommendations Sustainability Environment, People and Gender Equality. To help achieve an immediate sustainable environment and comply with the objective of action number 5: "Healthy, environmentally and socially sustainable teaching and research" of the "Green Campus Action Plan of the Faculty of Science".

- 1.- The delivery of the documentary work to be carried out in this subject will be done through Moodle, in digital format without the need to print them.
- 2.- The importance of ethical principles related to the values of sustainability in personal and professional behaviour must be taken into account.
3. The full integration of students who, for physical, sensory, mental or socio-cultural reasons, experience difficulties in gaining suitable, equal and beneficial access to university life will be facilitated.
4. Work will be carried out to identify and modify sexist prejudices and attitudes, and the environment will be influenced in order to modify them and promote values of respect and equality. Likewise, if adverse gender-based situations are identified, measures will be taken to correct them.
5. It is understood that university students must have acquired language skills in relation to oral and written expression. Therefore, spelling (spelling, accentuation and punctuation), grammatical and lexical correctness in assignments and exams will be essential and compulsory in order to pass the subject.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.