Analytical Nanobiosystems

Code: 103274
ECTS Credits: 6

2024/2025

Degree	Type	Year
2501922 Nanoscience and Nanotechnology	OT	4

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

To enroll in any fourth year subject, you must have a minimum of 120 ECTS approved and all the first course passed (Academic Affairs Committee of the Faculty of Sciences of February 27th 2007).
It is convenient to have passed the subjects of Analytical Chemistry and Supramolecular Chemistry / Molecular Recognition

Objectives and Contextualisation

To apply the concepts, principles, theories and fundamental facts related to nanoscience and nanotechnology in the systems for chemical analysis and diagnosis. Familiarize yourself with the new bio-inspired analytical systems. To illustrate this application of the convergence of technologies that combines nanomaterials and biotechnology.

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.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.

- 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.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. "Identify in the bibliography scientific studies of interest on analytical nanobiomaterials and nanobiosystems; correctly interpret the physical, chemical and biological bases of these works."
2. Adapt to new situations.
3. Be ethically committed.
4. Communicate clearly in English.
5. Communicate orally and in writing in one's own language.
6. Correctly use the necessary computer tools to interpret and expose the results obtained.
7. Evaluate the danger and risks of the use of samples and reagents, and apply suitable safety precautions for each case.
8. Evaluate the environmental impact of the nanomaterials and processes used in bionanotechnology.
9. Identify integrated analysis systems and analytical methodologies based on nanomaterials.
10. Interpret analytical results and their quality.
11. Learn autonomously.
12. Manage the organisation and planning of tasks.
13. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
14. Operate with a certain degree of autonomy.
15. Perform experiments with analytical nanobiosystems.
16. Present brief reports on biology and bionanotechnology in English.
17. Propose creative ideas and solutions.
18. Reason in a critical manner
19. Recognise the English terms employed in biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
20. Recognise the application of analytical nanobiosystems to large scale analysis.
21. Resolve problems and make decisions.
22. Safely handle the nanoparticles and nanomaterials used in biological systems.
23. Show motivation for quality.

24. Show sensitivity for environmental issues.
25. Understand texts and bibliographies in English on biochemistry, molecular biology, microbiology, immunology and in subjects related with nanoscience and nanotechnology.
26. Understand the design and operation of specific analytical nanobiosystems, and resolve quantitative problems related with these technologies.
27. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

The syllabus of the subject is subdivided into the following lessons:

1. Integration in analytical chemistry. Integration of the analytical process. Chemical sensors and biosensors. Immobilization. Miniaturization. Multiplexed (bio)sensors and micro / nanosystems.
2. The biological element: use of cells, enzymes - detection of substrates or inhibitors. Antibodies and other proteins for recognition, oligonucleotides and aptamers, molecularly imprinted polymers.
3. Nanomaterials and nanofabrication: nanoparticles, quantum dots, magnetic particles, fullerenes, nanotubes, nanoespheres, nanowires, graphene, dendrimers, nanoarrays, nanopores.
4. Surface phenomena in systems for analysis. Self-assembled monolayers. Langmuir-Blodgett films. Liposomes. Functionalization of surfaces. Printing and lithography at the nanometric scale.
5. Immobilization of biomolecules. General principles of immobilization. Non-covalent immobilization: adsorption, entrapment. Sol-gel matrices. Covalent immobilization via amino or thiol groups. Click-chemistry reactions. Affinity: avidin-biotin interaction, hexahistidine group and Ni (II). Strategies for oriented immobilization.
6. Analytical methodologies using nanomaterials. Labeling. Competitive, capture or signaling strategies. Reduction of non-specific interaction. Blocking. Stabilization. Amplification of signals.
7. Systems with electrochemical transduction. Potentiometry: Selective electrodes and FETs. Voltammetry. Systems with enrichment. Electrochemical impedance spectroscopy.
8. Systems with optical transduction. Principles of optical measurement with the use of nanocomponents. Continuous methods and with resolution of time. Fluorescence Methods: FRET, "up-converting" fluorophores. Evanescent wave: SPR and SERS.
9. Other principles of transduction. Systems with mass transduction. Quartz microbalance and surface acoustic wave sensors. Systems with magnetic transduction. Bioinspired Systems: Electronic noses and electronic tongues.
10. Biosensors based on Nanoporus. Nanometric porosity arrays. Intercalation of Ion channel proteins. Stochastic biosensors. Applications in sequencing.
11. Systems with micro and nanofluidics. Lateral flow devices. Lab on a chip and on a CD. Electrophoresis on chip. Chips in genomics and proteomics. Field-flow fractionation. Nanorobots.
12. Nanobiosensors for clinical diagnosis. Teranostics. Glucose and metabolites, protein markers, cancer markers, DNA, viruses, bacteria, isolation and CTC detection. Application of analytical nanobiosystems for large-scale analysis.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
i. Theoretical lectures	32	1.28	1, 2, 11, 8, 26, 25, 4, 5, 23, 12, 9, 3, 24, 13, 14, 17, 18, 19, 20, 21, 27
ii. Problem classes	12	0.48	1, 2, 11, 8, 26, 25, 4, 5, 23, 16, 12, 10, 3, 24, 13, 14, 17, 18, 19, 21, 27, 6

iii. Laboratory	12	0.48	2, 11, 8, 25, 4, 5, 23, 15, 12, 10, 22, 3, 24, 13, 14, 17, 18, 19, 20, 21, 27, 6, 7
Type: Supervised			
i. Search of information for oral presentations	12	0.48	1, 11, 26, 25, 12, 9, 13, 14, 18, 19, 20
Type: Autonomous			
i. Personal study	40	1.6	2, 11, 26, 25, 23, 12, 9, 3, 13, 14, 17, 18, 19, 20, 21, 27
ii. Troubleshooting	20	0.8	1, 2, 11, 26, 25, 4, 5, 23, 16, 12, 10, 3, 24, 13, 14, 17, 18, 19, 21, 27, 6
iii. Preparation of oral presentations	12	0.48	1, 2, 11, 26, 25, 5, 16, 9, 10, 3, 13, 14, 17, 18, 19, 20, 27, 6
iv. Reading of laboratory scripts	1	0.04	2, 11, 8, 5, 23, 15, 12, 10, 22, 3, 24, 14, 17, 18, 19, 20, 27, 6, 7

Students will have to develop various types of activities throughout this course:

a) Guided activities: Classes will be held on the contents of the subject with audiovisual support (materials deposited on the virtual campus) and classes of problems.
Numerical exercises will be used in the classes of problems about the contents of the course, and in addition the students will present presentations of scientific articles related to the subject.
For each lesson 7 to 12 (included), the teacher will prepare a list of scientific articles. Each student will choose one of the articles, and they will expose and analyze these works in an individual oral presentation of 10 min, with a question session, so that each student will carry out various presentations throughout the course. As laboratory sessions, we visit Analytical Chemistry laboratories that carry out research related to Nanoscience and Nanotechnology.
The materials needed for these activities will be found in the space of the course on the Virtual Campus.

b) Supervised activities: Tutorials will be carried out in order to monitor the preparation of oral presentations.

c) Autonomous activities: Students will have to study the contents of the course, solve problems, prepare laboratory practices and prepare various presentations on scientific articles related to the subject

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.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First partial exam	33%	4	0.16	2, 11, 8, 26, 25, 23, 12, 9, 10, 3, 24, 13, 14, 17, 18, 19, 20, 21, 6
Laboratory	coeficient multiplicatiu (entre 0.90-1.10)	0	0	2, 11, 8, 26, 4, 23, 15, 12, 9, 10, 22, 3, 24, 13, 14, 17, 18, 20, 21, 27, 6, 7
Oral	34%	1	0.04	1, 2, 11, 8, 25, 4, 5, 23, 16, 12, 9, 10, 3, 24, 13, 14,

presentations				17, 18, 19, 20, 27, 6
Second partial exam	33%	4	0.16	2, 11, 8, 26, 25, 23, 12, 9, 10, 3, 24, 13, 14, 17, 18, 19, 20, 21, 6

The assessment of the students will consist of several written and oral components:

- Written exams: There will be two partial exams throughout the course, one in half and the other at the end of the semester (33% each). The test will consist of a test part and a writing part. You must obtain a minimum score of 4 to be promoted by the final grade.

- Oral presentations, each student will do several during the course, lasting 10 min, summarizing scientific articles that are representative of the syllabus. The articles, corresponding to lessons 7,8,9,10, 11 and 12, will be chosen by the students from a list proposed by the teacher (34%).

- Students who need to improve the written part, may take a final exam at the end of the semester, which will replace 66% of the corresponding grade, and that will include the whole course. In order to be able to attend this final exam, it must have been evaluated before a minimum of 2/3 of the continuous assessment activities.

Students who have chosen the single assessment modality will have to take a final examination which will consist of a test-type part and a second part in the form of short questions. This test will be carried out on the day that the students of the continuous assessment take the second part exam. When he has finished, he will deliver a number of written works equivalent to those made by his colleagues as oral presentations, but in the form of a critical comment on the chosen scientific work.
The student's grade will be the weighted average of the three previous activities, where the test exam will account for 33% of the grade, the short question exam 33% and the written assignments the other 34%.
If the final grade does not reach 5, the student has another opportunity to pass the subject through the retake exam that will be held on the date set by the Coordination. In this test you can recover 66% of the grade corresponding to the theory and the problems.The part of the written works is not recoverable.

Bibliography

Nanobiosensing. Principles, development and application
H. Ju, X. Zhang, J. Wang
Springer, Heidelberg, 2011
ISBN 978-1-4419-9621-3

Nanomaterials for biosensors
C. Kumar
VCH Verlag, Weinheim, 2007
ISBN 978-3-527-31388-4

Chemical Sensors
P. Gründler
Springer, Heidelberg, 2007
ISBN 978-3-540-45742-8

Chemical Sensors and Biosensors: Fundamentals and Applications
F.G. Bănică
Wiley, Chichester, 2012
ISBN 978-0-470-71067-8

Software

N/A

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	1	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed