

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

Contact

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Teachers

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Use of languages

Principal working language: english (eng)

Prerequisites

Students interested in performing this module should have background in different areas of chemistry (Analytical Chemistry, Physical Chemistry, Inorganic Chemistry and Organic Chemistry), as well as basic knowledge in Mathematics, Physics and Biology. Students should also have adequate training for the experimental material handling and laboratory instruments and be able to perform usual tasks in a chemical lab, have the skills and abilities to management of common office applications, possess the English knowledge necessary for understanding lectures, scientific texts, documents, seminars and conferences. Both graduates, as well as degree in Chemistry, Chemical Engineering, Materials Science, Nanoscience, Environmental Sciences, Biotechnology, Biochemistry have enough background to take part of this module. Advanced level of English (level B1) of the Common European Framework Reference for Languages of the European Council is required.

Objectives and Contextualisation

The role of bioanalytical, bioorganic and bioinorganic chemistry in genomics, proteomics, metabolomics and medicine.

- Applying basic concepts of chemistry in biological systems in the field of human health, environmental control, food safety and biotechnology industry.
- Integrating bio recognition and biological reactions in chemical methodology.
- Using the most common techniques in chemistry to analyze, separate, identify and synthesize compounds in a biological context.
- Applying this knowledge to solve daily problems.

Skills

- 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
- 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. Apply general methods for analysing and characterising biomolecules.
2. Communicate and justify conclusions clearly and unambiguously to both specialised and non-specialised audiences.
3. Continue the learning process, to a large extent autonomously
4. Design synthesis strategies and recognise the properties of natural products.
5. Differentiate between ligand-receptor interactions and relate these to specific biorecognition processes.
6. Identify the contribution of biomolecular chemistry to medical and biomedical applications.
7. Recognise the structure of biomolecules and mimetics and relate this to their biological function.
8. Seek out information in the scientific literature using appropriate channels, and use this information to formulate and contextualise a research topic.
9. 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.
10. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
11. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
12. Use modified biomolecules in bioanalysis.

Content

Topics

- Structure, function and biorecognition of natural and recombinant biomolecules such as enzymes, antibodies, DNA, cellular receptors, DNA/RNA, metal-containing biomolecules. Biomimetics.
- Molecules for medical diagnosis and therapy
- Structure and function of medicinal natural products. Groundwork in natural product chemistry and phytochemistry.
- Computational Techniques in Biomolecular Chemistry. Relationship between chemical, biological and conformational space.
- Biomolecule production. Monoclonal and polyclonal antibodies. Recombinant proteins. Separation of biomolecules and labelling with nanotags. Bioanalysis. Immunoassays, PCR, biological catalysed methods.
- Integration of nanomaterials in rapid diagnostic test (lateral flow, biosensors, agglutination test, immunoassays) for diagnostics of emerging infection diseases.

Biomolecules & Biomimetics. Structure, function and biorecognition

Contents: Proteins: enzymes, affinity proteins, antibodies, diabodies, affibodies, avimers, cellular receptors. Biorecognition and function: enzyme/substrate; antigen/antibody; receptor/ligand interaction. Cell signaling. DNA/RNA structure and function. Amplification. Molecular beacons. Aptamers. Molecular imprinted polymers and plastic antibodies.

Metal-containing biomolecules: structure, function, and mimetics.

Content: The biochemistry of metal ions. Uptake, transport and storage of metal ions in biology. Electron transfer, respiration, and photosynthesis. Oxygen metabolism. Other metalloproteins of interest. Metal ion receptors and signaling. Metals in medicine.

Computational Techniques in Biomolecular Chemistry

Content: Specificities of computation at the interface chemistry-biology. Relationship between chemical, biological and conformational space. Protein-ligand dockings. Molecular Dynamics. Multiscale. Advantages, limitations. Reactivity in biochemical systems. Examples.

Chemistry and biomedicine: molecules for medical diagnosis and imaging

Content: General aspects of imaging techniques. SPECT radiopharmaceuticals based on Tc-99m (nuclear and chemical properties, kit reactions and some examples of relevant technetium radiopharmaceuticals). Other SPECT radiopharmaceuticals. PET radiopharmaceuticals, 18F-Fluorodeoxyglucose and C-11 radiotracers. Therapeutic radiopharmaceuticals. Magnetic resonance imaging contrast agents.

Natural products: biosynthesis and properties

Content: Natural products in drug discovery and therapeutic medicine: historical overview. Carbohydrates, the sweet molecules of life. The acetate pathway: fatty acids and polyketides. The mevalonate pathway: terpenoids and steroids. The shikimate pathway: aromatic aminoacids and phenyl propanoids. Alkaloids, secrets of life.

Biomolecule production, separation, modification and determination

Contents: Isolation and production of biomolecules. The immune system: production of polyclonal and monoclonal antibodies. Separation strategies. Labelling with nanotags and immobilization of biomolecules on nanostructured materials. Bioanalysis: immunochemical methods, DNA assays, PCR, biological catalysed methods, other biological catalysts: DNAzymes, biosensing. Chips and arrays.

Nanomaterials in biosciences

Contents: Biorecognition with biologically-modified quantum dots, carbon nanotubes, metal and magnetic nanoparticle: medical diagnosis, nanomedicine and bioanalysis. The Ebola Virus Project: design of a rapid diagnostic test for Ebola hemorrhagic fever, according to the OMS recommendation, in low resource settings in the developing world to screen out patients with requires strict surveillance and quarantine.

Methodology

Lectures

Problem-solving lectures

Cooperative activities

Seminars Preparation and oral presentation of papers

Tutorials

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			

Lectures	34	1.36	3, 5, 6, 7, 8, 10, 11
Problems	13	0.52	9, 10, 11, 12
Type: Supervised			
Tutorials	5	0.2	2, 3, 8
Type: Autonomous			
Autonomous learning and studying	52	2.08	1, 3, 4, 5, 6, 7, 8, 10, 12
Preparation of oral presentation and papers	40	1.6	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12

Evaluation

The evaluation of this module will take into account the attendance and participation in class as well as the work and assessments presented by the students. The different topics presented by each of the professors will be separately evaluated.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Oral defense of projects	40%	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Reports and problems	30%	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Writing Assessments	30%	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12

Bibliography

Medicinal natural products. A biosynthetic approach, P.M. Dewick, Jonh Wiley & Sons, 2002

Química Bioinorgánica, J. S. Casas, V. Moreno, A. Sánchez, J. L. Sánchez, J. Sordo, Editorial Síntesis, Colección Biblioteca de Químicas, 2002

Bioanalytical Chemistry, S. Mikkelsen, E. Corton, Wiley, 2004

Molecular Modelling Principles and Applications - Second Edition -Andrew R. Leach - Ed: Prentice Hall 2001

Further bibliography

Natural Products: their chemistry and biological significance, J. Mann, R.S. Davidson, J. B. Hobbs, D.V. Banthorpe, J. B. Harborne Prentice Hall, 1994

Natural Products Chemistry: A mechanistic and biosynthetic approach to secondary metabolism, K.B.G. Torsell, John Wiley & Sons, 1983

Inorganic Chemistry in Biology, P. C. Wilkins, R. G. Wilkins, Oxford Chemistry Primers, n. 46, Oxford University Press, 1997

Principles of Bioinorganic Chemistry, S. J. Lippard, J.M. Berg, University Science Books, 1994

Principles and Practice of Bioanalysis, R. F.Venn, (Editor), Taylor & Francis, 2000.

Bioanalytical Chemistry, A. Manz, N. Pamme, D. Iossifidis, Imperial College Press, 2004.

Principles of Chemical and Biological Sensors, D. Diamond (Editor), Wiley, 1998.

Biosensors, Elizabeth A. H. Hall, Open Univ Press, 1991