Universitat Autònoma de Barcelona

2023/2024

Bioanalytical Chemistry

Code: 102519
ECTS Credits: 6

Degree	Type	Year	Semester
2502444 Chemistry	OT	4	2

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

Rosanna Rossi

Prerequisites

This subject comprises disciplines such as analytical chemistry, biochemistry, materials science, organic chemistry, nanotechnology, among others.

It is highly recommended to have background and competences of the following topics: Fundamentals of Chemistry, Molecular and Cell Biology, Analytical Chemistry and Electroanalysis, and finally Biochemistry.

Objectives and Contextualisation

Bioanalytical Chemistry arises as a result of the convergence of Analytical Chemistry and Biochemistry and addresses the design and application of novel specific and sensitive analytical techniques. The term Bioanalytical Chemistryinvolves not only the resolution of biological samples or bioanalytes, but also to the use of the biological reaction and the biomolecular reagent to obtain analytical information. This approach is influencing decisively in the development of new bioanalytical methodologies, with several advantages over traditional analytical methods. A main issue of classical Analytical Chemistry, the selectivity, can be solved by the integration of biological reagents, providing specificity. Furthermore, the biorecognition may simplify the analytical procedure by avoiding complex treatments of the sample. On the other hand, the integration of biological origin allows to improve the limits of detection.
Currently, the methods used in Bioanalytical Chemistry include, beside the classic analytical instrumental methods, such as chromatography and mass spectrometry, other methods derived from molecular biology, including PCR (polymerase chain reaction), enzymatic or immunological methods. The main objectives of this subject are summarized below:

-To apply the basic concepts of analytical chemistry to real biological systems, which are relevant in different fields, mainly human health, environmental control, food safety and biotechnology industry.

-To integrate the bio-recognition and the biological reactions to the analytical methodology.

- To use the most common techniques in chemistry to analyze, separate and identify compounds within a biological framework.

- To apply this knowledge to the resolution of bioanalytical problems.

Competences

- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Communicate orally and in writing in one's own language.
- Develop synthesis and analyses studies in chemistry from previously established procedures.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Classify biomolecule marking methodologies to obtain better analytical signals.
3. Communicate orally and in writing in one's own language.
4. Design biorecognition based bioanalytical strategies to solve real cases of concern mainly in the fields of human health, environmental control, food safety and the biotechnology industry.
5. Evaluate biorecognition applied to an analytical method.
6. Identify different strategies for the immobilisation and marking of biological material.
7. Learn autonomously.
8. Manage the organisation and planning of tasks.
9. Manage, analyse and synthesise information.
10. Obtain information, including by digital means.
11. Propose creative ideas and solutions.
12. Reason in a critical manner
13. Recognise immobilisation methodologies in ideal solid supports for preserving the structure and function of a biomolecule.
14. Recognise the instrumental concepts and techniques of analytical chemistry applied to biological analyses.
15. Reproduce the most common chemistry techniques to analyse, separate and identify compounds in a biological setting or using biological reagents for analysis.
16. Resolve bioanalysis problems based on enzymes, antibodies and DNA as an analyte or element of biorecognition in the environmental, clinical and food fields.

17. Resolve problems and make decisions.
18. Show initiative and an enterprising spirit.
19. Show sensitivity for environmental issues.
20. Use IT to treat and present information.
21. Work in a team and show concern for interpersonal relations at work.

Content

LESSON 1

Introduction to Bioanalytical Chemistry. Safety and risks in the biochemistry laboratory. The bioanalytical methodology. Obtaining samples. Qualitative (screening) assays vs. quantitative Assays. Data fitting and statistical treatment. Validation of bioanalytical methods. Sensitivity and specificity. Matrix effect. Interferences.

LESSON 2

Structure of biomolecules and Biorecognition. Amino Acids, Peptides and Proteins. Antibodies. Enzymes. Nucleic Acids. Biorecognition: Enzyme/Substrate. Antigen/antibody. Hybridization. Other affinity interactions in nature. Strept(avidin), Protein A and G. Aptamers. Biomimetic recognition. The importance of water in biorecognition. Biological buffers.

LESSON 3

Separation methods of biomolecules. Electrophoresis of proteins and DNA. Gel Electrophoresis (GE). SDS Polyacrylamide Gel Electrophoresis (SDS-PAGE). Southern, Northern and Western blot. Applications of Electrophoresis. Diagnosis of Genetic (Inherited) Disease. Paternity and forensic testing. DNA Sequencing. Diagnosis of infection diseases.
Chromatography. Liquid Chromatography for Bioanalysis. Reversed Phase Liquid Chromatography (RP-LC). Ion Exchange Chromatography (IEC). Size Exclusion Chromatography (SEC). Affinity Chromatography. Protein Sequencing. The special case of protein purification from natural sources. Purification of antibodies Part 1 and Part 2. The special case of magnetic bioseparation.

LESSON 4

Instrumental techniques for the detection of biomolecules. Spectrophotometry and Fluorimetry. UV-VIS, turbidimetry, X-rays. Mass spectrometry for biomolecules. Genomics, proteomics and metabolomics.

LESSON 5

Enzymatic analysis. Enzymes in bioanalytical chemistry. Enzymatic kinetics. Examples of reactions catalyzed by enzymes. Enzymatic inhibitors. Quantification of enzymes and their substrates. Clinical Examples. Creatinin. Glucose. Uric Acid. Urea. Colesterol. Aspartate aminotransferase (GOT or AST). Alanine aminotransferase (ALT or GPT). γ -glutamyl transferase (γ-GT).

LESSON 6

Immunoassay. Classification Applications. Heterogeneous and homogeneous immunoassay. Labelling: radioisotopes, fluorescence, chemiluminescence. Enzyme labelling: ELISA. Data fittings. Statistical treatment. Validation. Sensitivity and specificity. Matrix effect.

LESSON 7

DNA analysis. Hybridization. DNA amplification. PCR and Q-PCR. Detection strategies. Isothermic techniques for amplification of DNA. Gene expression chips.

LESSON 8

Rapid and screening methods. Immunocromatography and reactive strips. Agglutination techniques. Chemical sensors and biosensors. Laboratories on a chip. Applications.

LESSON 9

Production of bioreactives and biomolecules. Synthesis of oligonucleotides and peptides in solid phase. Production of monoclonal and polyclonal antibodies. Synthesis of immunogenic haptens.

LESSON 10

Immobilization of biomolecules. Strategies in solid phase in bioanalytical chemistry. Types, characteristics and nature of solid supports. Strategies for the immobilization of biomolecules in solid supports. Evaluation of nonspecific adsorption.

LESSON 11

Labelling of biomolecules. Labelling and modifications with functional groups. Conjugation of biomolecules to different tags: enzymes, fluorophores, nanoparticles and QDs, biotin. Signal amplification techniques.

Methodology

Lectures

The lectures will be based on audiovisual support, and the material will be available in advance. The professor will offer an overview of the topic discussed, will focus on those key concepts for understanding and respond to possible doubts or questions. In addition, the professor will propose training activities that can be done in groups or individually. The training activities will be carried out in and / or outside the classroom and have as an objective the resolution of problems and / or the search for information. The activities are designed to encourage the learning of specific competences. The activities carried out outside the classroom must be delivered within the set period of time. On the other hand, students are required to work independently with the objective of reinforcing knowledge based on reading and understanding of the proposed reference books, web pages or books that can be provided for specific topics.

Classes of problems and seminars

The knowledge acquired in the lectures will be applied to solve questions and problems. The statements of the problems will be provided in advance. The professor will develop this activities following two different strategies: (a) The teacher will solve during the class some problems selected so that the student identifies the essential elements of the approach and how to address the resolution. B) Students, in small groups, guided and helped by the professor, face similar problems and questions or new approaches.

Throughout the semester, seminars will be devoted to the presentation of work on selected applications of the techniques studied. With these seminars we intend to study in depth the aspects dealt with in theory classes.

Bioanalytical Chemistry Laboratory

Practicum PRO. Spectrophotometric quantification of proteins in food, environmental and clinical samples: BCA and Bradford.

Practicum IA. ELISA (Enzyme-Linked ImmunoSorbent Assay) for the detection of IgG in colostrum of mares.

Practicum RDT. Rapid diagnostic tests based on lateral flow assays and biosensors.

Material available on the web page

http://isabelpividori.net/quimica-bioanalitica/

Teaching guide

Lectures power point Presentation

Problems and exercises

Multimedia support

Calendar of teaching activities

Bibliography

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			
Bioanalytical Chemistry Laboratory	12	0.48	6, 14, 13, 15, 5
Lectures	28	1.12	2, 6, 10, 14, 13, 5
Problems and exercises	10	0.4	1, 18, 4, 11, 15, 16, 17, 21
Type: Supervised			
Supervision	8	0.32	7, 8, 9, 12, 17
Type: Autonomous			
Problems and Exercises	36	1.44	1, 7, 18, 4, 8, 9, 10, 11, 12, 16, 17, 20
Study	48	1.92	1, 7, 2, 8, 9, 10, 12, 14, 13, 16

Assessment

The competences of this subject will be evaluated by means of:

a) Middle term test (individual assessment), including the 1st part of the subject. 35% of the final mark.

b) Final term test (individual assessment), including the 2nd part of the subject. 35% of the final mark.

c) If a student fails in any of the two tests (mark below 5.0), there will be a final exam including the whole subject (individual assessment). 70% in the final mark.

d) Collaborative amd other activities. 15% of the final marks.

e) Bioanalytical Chemistry Laboratory. The laboratory practices will be evaluated by means of the laboratory reports (50%) and the accomplishment of a test in the second partial exam (50%). The average mark obtained from laboratory practices will be equivalent to 15% of the final grade for the course. It is mandatory to pass the laboratory with a mark above 5.0.

To pass the subject, a minimum mark of 5 points (over 10) is required as the average of collaborative controls and other activities. The laboratory assistance in the three session is also mandatory.

f) To participate in the final 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.

One-single final assessment: Students who have opted for the "one single final assessment modality" will have to take a final test consisting of an exam covering the entire theoretical content and problem-solving exercises of the subject. This test will be held on the same day as the regular assessment students take the second partial exam. The student's final grade will be calculated as follows: Subject Grade = (Final Test mark * 0.85 + Laboratory Mark * 0.15). If the final mark does not reach 5, the studenthas another opportunity to pass the subject through a recovery exam, which will take place on a date set by the degree program coordination. In this recovery test, it will be possible to recover 85% of the grade corresponding to the theoretical part. The practical component is not recoverable. It is mandatory to pass the laboratory (minimum grade of 5.0).

VERY IMPORTANT: Partial or total plagiarising will immediately result in a FAIL (0) for the plagiarised exercise or laboratory report (first time) or the WHOLE subject (if the situation is repeated). PLAGIARISING consists of copying text from unacknowledged sources -whether this is part of a sentence or a whole text - with the intention of passing it off as the student's own production. It includes cutting and pasting from internet sources, presented unmodified in the student's own text. Plagiarising is a SERIOUS OFFENCE.Students must respect authors' intellectual property, always identifying the sources they may use; they must also be responsible for the originality and authenticity of their own texts. In the event of a student committing any irregularity that may lead to a significant variation in the grade awarded to an assessment activity, the student will be given a zero for this activity, regardless of any disciplinary process that may take place. In the event of several irregularities in assessment activities of the same subject, the student will be given a zero as the final grade for this subject.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Bioanalytical Chemistry Laboratory	15	1	0.04	4, 14, 15, 16, 5
Deliverables and seminars	15	1	0.04	1, 3, 18, 4, 8, 9, 19, 10, 11, 12, 15, 16, 17, 21, 20
Final term test (individual assessment)	35	3	0.12	7, 2, 3, 9, 6, 14, 13, 16, 17, 5
Middle term test (individual assessment)	35	3	0.12	7, 3, 9, 14, 16, 17, 5

Bibliography

- Bioanalytical Chemistry. Susan R. Mikkelsen & Eduardo Cortón. Wiley-interscience. 2004.

- Principles and Techniques of Biochemistry and Molecular Biology. 6 ª ed. Edited by Keith Wilson & John Walker. Cambridge University Press. 2006.

- 'Bioquimica. Técnicas y Métodos'. Pilar Roca, Jordi Oliver y Ana Mª Rodríguez. Editorial Hélice. 2003.

- Principles and Practice of Bioanalysis. Edited by Richard F. Venn. Taylor & Francis, 2000.

Software

Office and GraphPad