Universidad Zaragoza

Academic Year/course: 2022/23

27141 - Bioorganic Chemistry

Syllabus Information

Academic Year: 2022/23
Subject: 27141 - Bioorganic Chemistry
Faculty / School: 100 - Facultad de Ciencias
Degree: 446 - Degree in Biotechnology
ECTS: 6.0
Year: 4
Semester: First semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

Bioorganic Chemistry studies the application of the principles of organic chemistry to the knowledge of biological processes at the molecular level. The study of biomolecules, their intracellular location and biological activity are essential to understand any biological process at the molecular level.

The general objective of the subject is to teach the possibilities offered by the application of basic knowledge of Organic Chemistry in all its aspects to the study of biological processes at the molecular level in different fields (glycobiology, molecular biology, drug design, biocatalysis in organic synthesis, bioorthogonal chemistry). Bioorganic chemistry is closely related to organic chemistry and biochemistry. Therefore, the objective is for the student to learn, firstly, the basic concepts of organic chemistry (chemical bonds, functional groups, mechanisms of organic chemistry reactions in biological chemistry) and biochemistry (functions of biomolecules and biomimetic molecules, molecular recognition, stereochemistry).

The second part of the course will deal with the use of Bioorganic Chemistry in drug synthesis, bioorthogonal chemistry and biocatalysis. This last aspect is of special relevance considering the importance of enzymes as fundamental catalysts in green chemistry and the application of milder and less polluting reaction conditions.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations Agenda 2030 (https://www.un.org/sustainabledevelopment), so that the acquisition of the

learning outcomes of the subject provide training and competence to contribute to some extent to their achievement.

contribute to some extent to their achievement.

- Goal 4: Quality Education (Targets 4.3 and 4.4)

- Goal 9: Industry, innovation and Infrastructure (Targets 9.4 and 9.5)

- Goal 12: Responsible consumption and production (Targets 12.4 and 12.5)

1.2. Context and importance of this course in the degree

Bioorganic Chemistry is a subject taught in the first semester of the fourth year of the Degree in Biotechnology and belongs to the optional training module. It has a teaching load of 6 ECTS credits, 3 theoretical (lectures) and 3 practical (1.5 of problems, 1 of computer laboratory practice and 0.5 of supervised work).

The subject is included in a block directly related to Biological Chemistry. The course aims to extend the knowledge acquired in other subjects (Organic Chemistry, Biochemistry, Structure of Macromolecules, Molecular Biology). During the theoretical classes and problem seminars students will acquire the basic knowledge and skills in the field of Bioorganic Chemistry. The theoretical training is completed with the elaboration of a written tutored work and its presentation in class, so that students learn how to search for and evaluate scientific information and how to write and communicate scientific contents, etc.

In the laboratory sessions, students will develop additional skills related to the contents of the subject through the use of scientific software to carry out molecular dynamics studies, which are fundamental for biological studies.

1.3. Recommendations to take this course

- review previous knowledge of Organic Chemistry, Biochemistry and Structure of Macromolecules.

- to actively participate in the theoretical and practical classes and tutorials, and to carry out the proposed problems and cases.

Students are also encouraged to consult specific books related to the subject, in addition to the material provided by the

lecturers in class (see 4.5. Bibliography and recommended resources).

2. Learning goals

2.1. Competences

After completing this course, the student will demonstrate competence in

Recognizing the molecular structure of compounds that are part of living systems

Understanding structure-activity relationships of a large number of biologically active compounds

Recognizing the impact that structural changes in simple biomolecules play in their biological activity

Identifying organic reactions that take place during the synthesis and modification of simple biomolecules

Designing simple syntheses of biomolecules and analogues able to mimic the activity of the natural substances

Understanding the mechanisms of action of enzymes through the analysis at the molecular level of active sites and enzyme-substrate interactions

In addition to these specific competences, the student will improve his/her ability to:

- solve problems

- select and analyse the information

- integrate knowledge

2.2. Learning goals

The student, to pass on the course, should be able to

Upon successful completion of the course, the student will be more competent to...

- Recognise the molecular structure of biomolecules.

- Identify the organic reactions that take place in the chemical processes of synthesis and modification of simple biomolecules.

- Recognise the impact that structural changes in simple biomolecules have on their activity at the biological level.

- Analyse the relationship between chemical structure, physico-chemical properties, reactivity and biological response of drugs.

- Explain molecular recognition phenomena through interactions between biomolecules, mainly carbohydrates, and their role in glycobiology.

- Understand the mechanism of action of various types of enzymes and apply enzyme catalysis to organic synthesis reactions.

- Design simple synthetic routes for bioorthogonal reactions.

- Choose and use appropriate tools to study biomolecule-biomolecule or biomolecule-drug interactions.

- Search for and analyse specific information related to bioorganic chemistry.

- Make presentations on topics related to bioorganic chemistry.

2.3. Importance of learning goals

The knowledge and understanding of this subject bring the student closer to the mechanisms that take place at the molecular level in any kind of biological chemical process, be it a recognition phenomenon or a chemical reaction itself. The learning outcomes of the subject will contribute to the student's training in the area of Biological Chemistry as it will allow him/her to identify the real process that takes place by being able to recognise the main interactions between atoms and the type of chemical-organic reactivity that occurs. The knowledge acquired in the subject is also relevant for different applications in Biotechnology and Biomedicine (drug design, study of biological processes, biocatalysis).

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate the achievement of the expected learning outcomes through the following evaluation activities

The assessment will be carried out face-to-face unless, due to the health situation, the provisions issued by the competent authorities and by the University of Zaragoza provide for it to be carried out online.

In order to pass this subject, students must demonstrate that they have achieved the expected learning outcomes by achieving a minimum overall score of 5 points out of a total of 10 in each of the proposed assessment activities.

CONTINUOUS ASSESSMENT

If the student chooses continuous assessment:

1. Individual work

The student will prepare a scientifically valid report on one of the examples or applications described during the course.

The teacher will propose a topic related to the subject of the course to each of the students enrolled. Depending on the number of students enrolled, the work will be done individually or in groups. The teacher will supervise the student's personal work, guiding him/her in the search for information and its evaluation. The work must be submitted in writing and subsequently presented and discussed in class. The maximum length of the work, including graphic material and bibliography, will be 15 pages.

The presentation of the report of the work will be done through the Moodle platform within the deadline indicated by the teacher at the beginning of the course. The deadline for submission of all assignments will be 23:59 hours on the set date. Papers will be checked automatically with the Unicheck anti-plagiarism system.

The presentation of the work in class will last 15 minutes.

Assessment criteria and requirements

Both the report and the presentation will be evaluated following the same criteria as for the evaluation of the Final Degree Project. The work will be graded from 0 to 10 and will contribute 30% to the final grade. It is mandatory to score at least 5 out of 10.

2. Internship report

The student will write a short report (maximum 4 pages) of the two practical sessions that will be submitted through the Moodle platform within one week from the end of the last face-to-face session. The deadline for submission of all reports will be 23:59 hours on the day set for each group. Only reports submitted through the Moodle platform will be accepted. The report will be graded from 0 to 10 and will contribute 10% to the final grade. It is mandatory to score at least 5 out of 10.

3. Theory exam at the end of the term.

There will be an exam which will usually consist of 15 multiple-choice questions and 2-3 essay questions or exercises covering basic concepts of the subjects covered during the course. The exam will take place on the dates determined by the Faculty of Science for this purpose during the official exam periods.

Assessment criteria and requirements

The exam will be graded from 0 to 10 and will contribute 60% to the final grade. It is mandatory to score at least 5 out of 10..

The following will contribute to the final grade of the course:

Individual work: 30%; Theory exam: 60%; Practical reports: 10%. Up to 1 additional point may be added to the final grade for active participation in the problem classes, in the discussions in the classroom and in the presentation of the work.

OVERALL ASSESSMENT

Students who so wish may opt for an overall final exam to judge whether the learning objectives of the course have been achieved. The exam will usually consist of 15 multiple-choice questions and 2-3 essay questions or exercises covering basic concepts of the subjects covered during the course. The exam will take place on the dates determined by the Faculty of Science during the official exam periods. The exam will be graded from 0 to 10 and will represent 100% of the final grade. It is essential to score at least 5 out of 10.

Fraud or total or partial plagiarism in any of the assessment tests will result in failure of the subject with the minimum grade, in addition to the disciplinary sanctions that the guarantee committee adopts for these cases. d.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The course involves the use the following teaching/learning methods and activities

The methodology followed in this course is oriented towards the achievement of the learning objectives. The methodology is based on cooperative work between teacher and student. To this end, lectures will be interspersed with problem-solving classes and case studies and practical classes.

Students are expected to participate actively in the class throughout the semester.

Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other course-specific learning materials, including a discussion forum.

Further information regarding the course will be provided on the first day of class.

4.2. Learning tasks

The teaching activities will be carried out face-to-face unless, due to the health situation, the provisions issued by the competent authorities and by the University of Zaragoza make it necessary to carry them out remotely or semi-remotely with rotating reduced seating capacity.

The syllabus offered to students to help them achieve the expected results includes the following activities:

- Lectures (30 hours). In these classes the lecturers will introduce students to the basic theoretical knowledge of the subject. In addition, a seminar may be given by invited researchers who are developing their research in the field of bioorganic chemistry.
- Classes of problem solving and case studies (15 hours). They will be interspersed with the theoretical classes to promote learning.
- Practical work (8 hours). Students will carry out docking studies of small organic molecules in proteins, localisation of allosteric sites in enzymes, and molecular dynamics to study the binding of substrates in enzymes. The software packages Schrödinger and AMBER will be used.
- Preparation and presentation of a paper (26 hours). This activity consists of students collecting information on a specific topic, with the help of the teacher, and preparing a paper that will be presented and discussed in class.
- Objective test (1 hour exam; 70 hours study). At the end of the course, students will take an objective test to evaluate the acquisition of basic concepts, procedures and other knowledge.

4.3. Syllabus

CONTENT OF THE LECTURES

Topic 1. Introduction to Bioorganic Chemistry. Reactions and mechanisms of organic chemistry in biological chemistry.

Topic 2. Biomolecules from the organic point of view. Structure, synthesis and reactivity. Biomimetic molecules.

Topic 3. Proteins. Non-proteinogenic amino acids. ?,?-Disubstituted amino acids, ?-amino acids. Asymmetric amino acid synthesis. Protective groups. Coupling methods.

Topic 4. Carbohydrates. Unnatural derivatives: aza- and thio-sugars, C-glycosides. Glycosylation reactions. Glycoconjugates. Molecular recognition based on carbohydrate interactions. Glycobiology.

Topic 5. Nucleic acids. Nucleosides and nucleotides. Synthesis of nucleosides and nucleotides. Leloir nucleotides.

Topic 6. Molecular recognition and catalysis. Application of enzymes in organic synthesis and biotechnology. Biocatalysis and biotransformations in the pharmaceutical industry.

Topic 7. Introduction to drug synthesis: discovery and activity. Relationship between chemical structure, physicochemical properties, reactivity and biological response of drugs.

Topic 8. Bioorthogonal chemistry. Main bioorthogonal reactions and their application in biology and biotechnology.

PROBLEM-SOLVING CLASSES AND CASES

These will correspond to the topics of the lectures, will include theoretical questions and exercises and will be interspersed with the lectures.

PRACTICAL CLASSES

The course will include docking studies of small organic molecules in proteins, localisation of allosteric sites in enzymes, and molecular dynamics to study the binding of substrates in enzymes. The software packages Schrödinger and AMBER will be used.

4.4. Course planning and calendar

The period of theory and problem classes will coincide with the officially established timetable. Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the

https://ciencias.unizar.es/grado-en-biotecnologia.

4.5. Bibliography and recommended resources

https://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=27140