COURSE DATA

Data Subject	
Code	36470
Name	Biological Organic Chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	Second term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	17 - Organic Chemistry Applied	Optional

Coordination

Name	Department
RAMIREZ DE ARELLANO SANCHEZ, MARIA DEL CARMEN	325 - Organic Chemistry

SUMMARY

The subject "Organic Biological Chemistry" is part of the "Applied Organic Chemistry" subject of 22.5 ECTS credits within the Chemistry, Industry and Society module. It is an optional subject of 6 ECTS credits that is taught in the 8th semester of the fourth year.

The basic objective of this subject is to deepen and expand the knowledge acquired in the Organic Chemistry courses. Its focus is mainly directed to the study of the compounds that are part of the biomolecules (carbohydrates, amino acids, nucleotides and also phospholipids), to study their characteristics and reactivity, as well as the formation of these biomolecules. Once deepened in this, we must study the weak interactions that are present and that will be the key of the enzymatic mechanisms.

Knowledge of these processes, which occur in all living organisms, is essential to provide the student with sufficient resources for its application in the design of new bioactive compounds

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Although the subject has a basic level, it is essential that the student has a solid formation in the terminology, nomenclature and structural properties of functional groups and organic molecules, that is, that has the learning bases of Organic Chemistry I, II and III. It is also important that the student is familiar with and demonstrates fluency with stereochemistry.
It is fundamental to have clear the fundamental concepts of Biochemistry.

OUTCOMES

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.
- Evaluate, interpret and synthesise chemical data and information.
- Recognise and evaluate chemical processes in daily life.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Applied Organic Chemistry that allow to acquire specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Biological Organic Chemistry related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Biological Organic Chemistry that contemplate the learning outcomes EUROBACHELOR®
The kinetics of chemical change, including catalysis; the mechanistic interpretation of chemical reactions	Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6).
The structure and reactivity of important classes o biomolecules and the chemistry of important biological processes	Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes..(CE12). Relate chemistry with other disciplines.(CE26).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Biological Organic Chemistry that contemplate the learning outcomes EUROBACHELOR®
Competences to present and argue scientific issues orally and in writing to a specialized audience.	Relate chemistry with other disciplines.(CE26). Prepare reports, surveys and industrial and environmental projects in the field of chemistry..(CE27). Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate. (CG6). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Biological Organic Chemistry that contemplate the learning outcomes EUROBACHELOR®
Competences in information management, in relation to primary and secondary sources, including information retrieval through on-line searches.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6).

	Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Study skills necessary for professional development. These will include the ability to work autonomously.	Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3). Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Learn autonomously.(CG8). Demonstrate the ability to adapt to new situations..(CG9). Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.(CB5).
Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf	Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.(CG10). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration. (CB3).

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to acquire a special sensitivity for the sustainable management of water (SDG 6), raw materials and energy sources (SDG 7) as well as for a sustainable development compatible with the environment (SDGs 11, 12, 13, 14 and 15)

DESCRIPTION OF CONTENTS

1. Fundamentals

Scope of study. Natural products. Primary and secondary metabolism. Introduction to enzymatic mechanisms. Frontier orbitals and reactivity. Hydrogen bond and proton transfer. Prebiotic chemistry. Nonbonding interactions Modular design of basic biooligomers.

2. ADN

Deoxyribonucleotides and DNA: aromaticity, acidity and basicity, hydrolysis and chemical modifications. DNA forms: base pairing, tautomery, pi-stacking, reversible folding, self-assembly, DNA ligases. DNA superstructure Replication of DNA. Chemical synthesis of DNA. Separation of DNA by electrophoresis. Recombinant DNA. Photochemistry of nucleic acids. DNA as a target in the design of cytotoxic drugs.

3. ARN

Ribonucleòtids. Estructura dARN. Síntesi dARN. Control transcripcional. Ribonucleotides. RNA structure. RNA synthesis. Transcriptional control. mRNA processing in eukaryotes. Controlled degradation of RNA. Ribosomal translation of mRNA into proteins. Libraries of proteins from oligonucleotides

4. Peptide and Protein structure

Amino acids and peptides. Solid-phase peptide synthesis. Secondary structure of proteins. Disulfide crosslinks. Functional and estructural role of proteins domains. Higher levels of protein structure.

5. Protein function

Receptor-ligand interactions. A quantitative view of enzyme function. A mechanistic view of enzymes that catalyze multistep reactions. Enzymes that use organic cofactors. Engineering improved protein function.

6. Glycobiology I

Structure and nomenclature of monosaccharides. Polar and stereoelectronic effects. Chemistry and enzymology of the glycosodic bond. Mechanism of reteining and inverting glycosyl hydrolases and transferases. Relevant disaccharides and polysaccharides. Homeostasis of glucose and diabetes. Sweeteners.

7. Glycobiology II

Glycoproteins: O- and N-glycosylation of human proteins. Glycoproteins in drugs and cell recognition processes. Glycolipids: glycosphingolipids, glycosylphosphatidylinositols. Glycosylation in the cytosol. Chemical synthesis of oligosaccharides. Function of glicans in cell recognition processes: lectins, cell adhesion, blood groups antigens, toxins. Analysis of protein-glycan interactions.

8. Polyketides and terpenes

The Claisen reaction in polyketide biosynthesis. Biosynthesis of fatty acids. The biological role of human polyketides. Non-human polyketides natural products. Bioactive peptides and secondary metabolites. Human terpenes. Non-human terpene natural products.

9. Chemical control of signal transduction

Signal transduction. Overview of signal transduction pathways in human cells. Nuclear receptors. Cell surface receptors and transcription factors. Receptor tyrosine kinases. G protein coupled receptors. Ion channel receptors. Tumor necrosis factor receptors. Small gaseous molecules receptors.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of individual work	10,00	0
Study and independent work	60,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The subject is designed for the student being the protagonist of their own learning. The subject structure is as follows:

- Theory lectures.- Two or three classes per subject for the discussion with the students of the most complicated subjects or those with present the higher difficulty. These classes are complemented by personal study time.
- Questions lectures.- These classes objective is the application of the knowledge that the students have acquired in theory classes. Students must have previously worked on the questions that will be solved. The resolution of these problems will be carried by the teacher or the students, either in a group or individually.
- Supervisions.- There will be 9 in total distributed evenly throughout the course. The duration of these sessions will be of one hour. The teacher will evaluate the learning process of the students. In the tutorial sessions the works that have been entrusted will be collected. Likewise, the tutorials will serve to solve all the doubts that may have arisen throughout the classes and will guide the students on the best methods for the resolution of problems that may arise. Advanced problems will also be proposed to stimulate students.

EVALUATION

The evaluation of the learning will be carried out continuously by the teacher, given the close contact that will be maintained throughout the course. The different sections that will be evaluated are the following:

1. Direct evaluation of the teacher (5 points): This evaluation will take into account different aspects, among which include:

- Attendance and participation reasoned and clear in the discussions.
- Progress in the use of the characteristic language of biological organic chemistry.
- Problem solving and raising doubts.
- Critical spirit.

2. Seminars of Organic Chemistry and Tutorials (globally 15 points): The note of each student in this section will take into consideration

- Attendance / participation.
- Knowledge of the material explained up to that moment.
- Correction of the problems assigned to each student.

3. Exams (80 points): The exams will take place on the dates indicated by the faculty. Throughout the course, there may be controls without prior notice to determine the evolution of continuous learning, whose qualification will be part of the "seminars and tutorials" section. The minimum number of points in this section is 40 points in order to pass the subject. The exams will consist of theoretical-practical questions related to the subject and relationship questions. Questions of relationship are understood as questions that oblige the student to relate aspects of the subject that appear in different topics. These questions will allow the teacher to assess both the student's global knowledge and his or her ability to express themselves in writing. The time spent on exams will be limited so that the student demonstrates his ability to outline and summarize.

REFERENCES

Basic

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- J. Clayden, N. Greeves and W. Stuart, Organic Chemistry, Oxford University Press, 2012. 2ª Edición.
- J. E. McMurry and T. P. Begley, The Organic Chemistry of Biological Pathways, Roberts & Company Publ., 2016, 2ª Edición.
- J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe and J. B. Harborne, Natural Products. Their chemistry and biological significance, Longman Scientific and Technical, 1994, 1ª Edición.
- P. M. Dewick, Essentials of Organic Chemistry, Ed. Wiley, 2006, 1ª Edición.

Additional

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- R. Cooper and G. Nicola, Natural Products Chemistry. Sources, Separations, and Structures, CRC Press, 2015, 1ª Edición.
- J. A. Marco, Química de los Productos Naturales, Editorial Síntesis, 2006, 1ª Edición.
- RCSB Protein Data Bank: biological macromolecular structures enabling breakthroughs in research and education, 2022, Helen M. Berman, et al., Nucleic Acids Research 2000, 28, 235
- KEGG: Kyoto Encyclopedia of Genes and Genomes, M. Kanehisa, Post-genome Informatics, Oxford University Press, 2000
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