



1. General information

Course: AMPLIFIED ORGANIC CHEMISTRY

Type: CORE COURSE

Degree: 398 - UNDERGRADUATE DEGREE PROGRAMME IN CHEMISTRY

Center: 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY

Year: 3

Main language: Spanish

Use of additional languages: Several materials in English

Web site:

Code: 57323

ECTS credits: 6

Academic year: 2020-21

Group(s): 20 23

Duration: C2

Second language:

English Friendly: Y

Bilingual: N

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2. Pre-Requisites

It is recommended to have taken and passed the modules/subjects Organic Chemistry I (Química Orgánica I) and Organic Chemistry II (Química Orgánica II).

3. Justification in the curriculum, relation to other subjects and to the profession

The subject Organic Chemistry is part of the module Fundamentals of Chemistry (Fundamentos de Química) of the Chemistry Degree. The objectives of this subject are to explain concepts and basic knowledge of Organic Chemistry; to show evidence that supports those said concepts; to use them to solve chemical problems; and to prove that this subject evolves quickly and plays an important role in modern technological developments of different fields, such as biology and materials science, being a crucial part of everyday life aspects.

The natural and organic products are studied in the course 'Ampliación de Química Orgánica'. The chemical reactions that all the living beings experiment implicate the primary metabolites of the four compounds that are essential to life: carbohydrates, lipids, proteins and nucleic acids. Nevertheless, there are other compounds that are not vital, but they usually contribute to the survival, known as secondary metabolites.

The course aims to study the reactivity of these compounds as well as to apply the previously acquired knowledge and concepts to the two main problems caused by the chemistry of natural products: the structural determination and their synthesis methods. Additionally, there will be included the isolation of natural products from an experimental point of view.

4. Degree competences achieved in this course

Course competences

Code	Description
CB02	Apply their knowledge to their job or vocation in a professional manner and show that they have the competences to construct and justify arguments and solve problems within their subject area.

E01	Understand and use chemical terminology, nomenclature, conventions and units
E03	Handle chemicals safely and with respect to the environment
E06	Know the structural properties of chemical compounds, including stereochemistry, as well as the main structural research techniques
E16	Plan, design and develop projects and experiments
G01	Know the principles and theories of Chemistry, as well as the methodologies and applications characteristic of analytical chemistry, physical chemistry, inorganic chemistry and organic chemistry, understanding the physical and mathematical bases that require
G02	Be able to gather and interpret data, information and relevant results, obtain conclusions and issue reasoned reports on scientific, technological or other problems that require the use of chemical tools
G03	Know how to apply the theoretical-practical knowledge acquired in the different professional contexts of Chemistry
G04	Know how to communicate, orally and in writing, the knowledge, procedures and results of chemistry, both specialized and non-specialized
T03	Proper oral and written communication
T11	Ability to obtain bibliographic information, including Internet resources

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Acquire the ability to interpret the experimental results, relating each experimental stage with the theoretical knowledge acquired

Acquire the necessary practical training to apply it in your professional life. Know the main methods of isolation, purification and characterization of organic compounds

Acquire the ability to handle chemical reagents and organic compounds safely.

Acquire an awareness of environmental protection developing the idea that Organic Chemistry should be used to improve the quality of life.

Learn to work autonomously in a laboratory and know how to interpret the experimental results obtained.

Know the stereochemistry of the compounds

Know the structure of the main organic functional groups

Know the structure and function of organic natural products.

Know the utility of the spectroscopic techniques in Organic Chemistry

Know the main aspects of the terminology and nomenclature in Organic Chemistry

Know the main preparation methods and the reactivity of the main organic functional groups and relate it to its structure

Know the basic principles of Organic Chemistry.

To ensure that the student is able to search and select information in the field of Organic Chemistry and that he / she is capable of processing and presenting it adequately both orally and in writing, developing his / her synthesis capacity, being critical and objective

To develop in the student the capacity of initiative to pose and solve concrete problems of Organic Chemistry, as well as to interpret the obtained results

Develop your ability to teamwork

Recognize the main reactive intermediates and the influence of stereoelectronic effects on their stability and reactivity

Know how to apply the knowledge of Organic Chemistry to the solution of synthetic and structural problems

Encourage and promote in the student all those values and attitudes inherent to scientific activity.

6. Units / Contents

Unit 1: AMINO ACIDS, PEPTIDES AND PROTEINS: Classification. Stereochemistry. Acid-base behavior. Isoelectric point. Analysis of amino acids. Synthesis methods. Enantioselective synthesis. Peptides. Determination of peptide structure: amino acid analysis. Sequence analysis. Analysis of terminal groups: N-terminal and C-terminal. Selective hydrolysis of peptides. Peptide synthesis strategy. Protection of the amino group. Protection of the carboxyl group. Activation and coupling. Peptide bonds formation. Peptides synthesis in solid phase. Merrifield method. Secondary structure of peptides and proteins. Tertiary structure. Coenzymes. Quaternary structure of proteins. Hemoglobin.

Unit 2: CARBOHYDRATES AND NUCLEIC ACIDS: Introduction. Classification. Fischer projections. D-L notation system. Aldoses and ketoses. Rosanoff classification. Cyclic forms: Furanoses, pyranoses. Mutarotation. Anomeric effect. Glycosides. Disaccharides. Polysaccharides. Cell surface glycoproteins. Reactivity of monosaccharides. Reaction with phenylhydrazine. Reduction. Oxidation. Reactions of epimerization, isomerization and retroaldol degradation. Reaction with acid. Formation of thioacetals. Reaction with carbonyl compounds. Chain extension. Aldose degradation reactions. Nucleic acids: nucleosides, nucleotides, nucleic acids.

Unit 3: METABOLITES DERIVED FROM ACETATE: Acetylcoenzyme A. Fatty acids, fats and waxes. Biosynthesis of fatty acids. Phospholipids. Prostaglandins. Thromboxanes. Leukotrienes. Terpenes. Isoprene rule and classification of terpenes. Biosynthesis of terpenes. Mevalonic acid route. Linear, monocyclic and bicyclic terpenes. Steroids: structure. Biosynthesis of cholesterol. Carotenoids: structure. Chemistry of vision.

Unit 4: OTHER SECONDARY METABOLITES: Polyphenols. Shikimic acid route. Galotanines. Hydroxycinnamic acids. Coumarins. Polyketides route. Naphthoquinones. Anthraquinones. Tetracyclines. Flavonoids. Isoflavonoids. Alkaloids. Alkaloids derived from ornithine and lysine. Alkaloids with pyrrolidine and piperidine structure. Alkaloids with pyrrolizidine and quinolizidine structure. Alkaloids with pyridine structure. Alkaloids derived from phenylalanine and tyrosine. Alkaloids derived from tryptophan: indole alkaloids. Alkaloids derived from purines.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	E01 E06 G01	0.64	16	N	-	
Class Attendance (practical) [ON-SITE]	Practical or hands-on activities	E01 E03 E06 E16 G01 T11	1.28	32	Y	Y	
Workshops or seminars [ON-SITE]	Problem solving and exercises	CB02 E01 E06 G02 G03 G04	0.32	8	Y	N	
Group tutoring sessions [ON-SITE]	Combination of methods	CB02 E01 E06 G02 G03 G04	0.04	1	Y	N	
Study and Exam Preparation [OFF-SITE]	Self-study	G02 T11	2.8	70	N	-	
Other off-site activity [OFF-SITE]	Problem solving and exercises	G02 T11	0.76	19	N	-	

Progress test [ON-SITE]	Combination of methods	CB02 E16 G02 G03 G04 T03	0.08	2	Y	N
Final test [ON-SITE]	Combination of methods	CB02 E16 G02 G03 G04 T03	0.08	2	Y	Y
Total:			6	150		
Total credits of in-class work: 2.44			Total class time hours: 61			
Total credits of out of class work: 3.56			Total hours of out of class work: 89			

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System			
Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
Assessment of problem solving and/or case studies	15.00%	0.00%	It will be positively evaluated the resolution of problems/exercises as well as in class participation. In addition, the student may increase their final grade by completing the exercises handed over by the professor.
Progress Tests	40.00%	0.00%	There will be a two hours mid-term to evaluate the learning of the student.
Laboratory sessions	20.00%	20.00%	The practical credits will be marked together during the diary lab work where there will be taken into account several aspects, such as dexterity, order, capacity for initiative. Additionally, there will be two exercises related to the practices in the final exam.
Final test	25.00%	80.00%	There will be a final exam of the module. Nonetheless, the students that have passed the mid-term would be able to avoid taking this final test.
Total:	100.00%	100.00%	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

It is recommended to come to class, however it is not compulsory.

Attendance of practices is compulsory and non-recoverable, and besides, it is essential to pass them in order to pass the whole module.

THE SUBJECT WOULD ONLY BE PASSED JUST WITH THE MID-TERM IF THE MARK OBTAIN IN IT IS AT LEAST A 4.5. Otherwise, the student will have to take a final exam of the whole subject (it will count as the 60% of the final grade) where the minimum grade will be a 5.

Non-continuous evaluation:

Evaluation criteria not defined

Specifications for the resit/retake exam:

In order to pass the subject in the second examination period the student will have to have passed the practices (which mark will be the 20% of the final grade) and take the exam (that will be the other 80% of the grade) where the minimum mark will be a 5.

9. Assignments, course calendar and important dates	
Not related to the syllabus/contents	
Hours	hours
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	32
Study and Exam Preparation [AUTÓNOMA][Self-study]	70
Other off-site activity [AUTÓNOMA][Problem solving and exercises]	19
Progress test [PRESENCIAL][Combination of methods]	2
Final test [PRESENCIAL][Combination of methods]	2
Unit 1 (de 4): AMINO ACIDS, PEPTIDES AND PROTEINS: Classification. Stereochemistry. Acid-base behavior. Isoelectric point. Analysis of amino acids. Synthesis methods. Enantioselective synthesis. Peptides. Determination of peptide structure: amino acid analysis. Sequence analysis. Analysis of terminal groups: N-terminal and C-terminal. Selective hydrolysis of peptides. Peptide synthesis strategy. Protection of the amino group. Protection of the carboxyl group. Activation and coupling. Peptide bonds formation. Peptides synthesis in solid phase. Merrifield method. Secondary structure of peptides and proteins. Tertiary structure. Coenzymes. Quaternary structure of proteins. Hemoglobin.	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	5
Workshops or seminars [PRESENCIAL][Problem solving and exercises]	2
Unit 2 (de 4): CARBOHYDRATES AND NUCLEIC ACIDS: Introduction. Classification. Fischer projections. D-L notation system. Aldoses and ketoses. Rosanoff classification. Cyclic forms: Furanoses, pyranoses. Mutarotation. Anomeric effect. Glycosides. Disaccharides. Polysaccharides. Cell surface glycoproteins. Reactivity of monosaccharides. Reaction with phenylhydrazine. Reduction. Oxidation. Reactions of epimerization, isomerization and retroaldol degradation. Reaction with acid. Formation of thioacetals. Reaction with carbonyl compounds. Chain extension. Aldose degradation reactions. Nucleic acids: nucleosides, nucleotides, nucleic acids.	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	6
Workshops or seminars [PRESENCIAL][Problem solving and exercises]	2
Group tutoring sessions [PRESENCIAL][Combination of methods]	1
Unit 3 (de 4): METABOLITES DERIVED FROM ACETATE: Acetylcoenzyme A. Fatty acids, fats and waxes. Biosynthesis of fatty acids. Phospholipids. Prostaglandins. Thromboxanes. Leukotrienes. Terpenes. Isoprene rule and classification of terpenes. Biosynthesis of terpenes. Mevalonic acid route. Linear, monocyclic and bicyclic terpenes. Steroids: structure. Biosynthesis of cholesterol. Carotenoids: structure. Chemistry of vision.	
Activities	Hours

Class Attendance (theory) [PRESENCIAL][Lectures]	3
Workshops or seminars [PRESENCIAL][Problem solving and exercises]	2
Unit 4 (de 4): OTHER SECONDARY METABOLITES: Polyphenols. Shikimic acid route. Galotanines. Hydroxycinnamic acids. Coumarins. Polyketides route. Naphthoquinones. Anthraquinones. Tetracyclines. Flavonoids. Isoflavonoids. Alkaloids. Alkaloids derived from ornithine and lysine. Alkaloids with pyrrolidine and piperidine structure. Alkaloids with pyrrolizidine and quinolizidine structure. Alkaloids with pyridine structure. Alkaloids derived from phenylalanine and tyrosine. Alkaloids derived from tryptophan: indole alkaloids. Alkaloids derived from purines.	
Activities	Hours
Class Attendance (theory) [PRESENCIAL][Lectures]	2
Workshops or seminars [PRESENCIAL][Problem solving and exercises]	2
Global activity	
Activities	hours
Class Attendance (theory) [PRESENCIAL][Lectures]	16
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	32
Workshops or seminars [PRESENCIAL][Problem solving and exercises]	8
Group tutoring sessions [PRESENCIAL][Combination of methods]	1
Study and Exam Preparation [AUTÓNOMA][Self-study]	70
Other off-site activity [AUTÓNOMA][Problem solving and exercises]	19
Progress test [PRESENCIAL][Combination of methods]	2
Final test [PRESENCIAL][Combination of methods]	2
Total horas: 150	

10. Bibliography and Sources						
Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Carey, F. A.	Química Orgánica, 6ª Ed.	McGraw-Hill		970-10-5610-8	2006	It can be found in the UCLM General Library
Claramunt Vallespí, R.; Farrán Morales, Á.; López García, C.; Pérez Torralba, M.; Santa María Gutiérrez, D.	Química Bioorgánica y Productos Naturales	UNED Editorial		978-84-362-6624-5	2013	It can be found in the UCLM General Library
García Calvo-Flores, F.; Dobado, J. A.	Problemas resueltos en Química Orgánica, 1ª Ed.	Thomson		978-84-9732-458-8	2008	It can be found in the UCLM General Library
Gil Ruiz, P.	Productos Naturales, 1ª Ed.	Univ. Pública de Navarra		84-95075-91-1	2002	It can be found in the UCLM General Library
Herbert, R. B.	The Biosynthesis of Secondary Metabolites	Chapman and Hall		0-412-27720-4	1989	It can be found in the UCLM General Library
Levy, D. E.; Fügedi, P.	The Organic Chemistry of Sugars, 1ª Ed.	CRC Press		978-0824753559	2005	
Mann, J.	Secondary Metabolism	Oxford Chemistry Series		0-19-855529-6	1987	It can be found in the UCLM General Library
Mann, J.; Davidson, S.; Hobbs, J.; Banthorpe, D.; Harborne, J.	Natural Products	Prentice Hall		978-0582060098	1994	
Marco, J. A.	Química de los Productos Naturales, 1ª Ed.	Sintesis		84-9756-403-0	2006	It can be found in the UCLM General Library
McMurry, J.	Organic Chemistry: with Biological Applications, 2ª Ed.	Brooks/Cole		9780495391449	2011	It can be found in the UCLM General Library
McMurry, J.; Begley, T. P.	The Organic Chemistry of Biological Pathways, 1ª Ed.	Robert & Company Publishers		0-9747077-1-6	2005	It can be found in the UCLM General Library
Meislich, H.; Meislich, E. K.; Sharefkin, J.	3000 Solved Problems in Organic Chemistry, 1ª Ed.	McGraw Hill		0-07-056424-8	1994	It can be found in the UCLM General Library
Vollhardt, K. P. C.; Schore, N. E.	Química Orgánica: Estructura y Función, 5ª Ed.	Omega		978-84-282-1431-5	2007	It can be found in the UCLM General Library
Wade, L. G. Jr.	Química Orgánica, 5ª Ed.	Pearson Educación		0-13-110310-5	2004	It can be found in the UCLM General Library