VNIVERSITAT DE VALÈNCIA

Course Guide
36454 Organic Chemistry II

COURSE DATA

Data Subject	
Code	36454
Name	Organic Chemistry II
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	2	Second term
1929 - Double Degree Program in Physics and Chemistry	Double Degree Program Physics and Chemistry	3	Second term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	9 - Organic Chemistry	Obligatory
1929 - Double Degree Program in Physics and Chemistry	3 - Tercer Curso (Obligatorio)	Obligatory

Coordination

Name	Department
COSTERO NIETO, ANA MARIA	325 - Organic Chemistry

SUMMARY

Organic chemistry is the branch of chemistry that studies the structure and reactivity of carbon compounds, generally known as organic molecules. Among these molecules are found the most essential compounds for life, such as lipids, carbohydrates, amino acids, proteins and nucleic acids. Also organic molecules are many substances with which we come into direct contact, such as fuels, glues, paints or textile fibers. A large group of organic compounds are those that have pharmacological activity and that are the basis of medicines. Pesticides, fertilizers and herbicides have changed agriculture and preservatives have helped to modify our eating habits. Now, not all organic compounds are beneficial, there are many of them that are harmful to health or to the environment and therefore, it is necessary to continue preparing compounds with better properties to replace those that present problems.

The knowledge of the structure and reactivity of organic compounds has the purpose of opening

ways for the preparation of compounds that maintain all their beneficial characteristics minimizing undesirable side effects.

The subject Organic Chemistry II is proposed as a continuation of knowledge acquired in Organic Chemistry I and will be complemented with Organic Chemistry III. Over all, they constitute the theoretical foundations of the Module of Organic Chemistry obligatory of the Degree in Chemistry and must be treated as a whole to show the perspective of the area that is intended to show the students.

The objectives that are intended to achieve in the subject can be summarized in the following points:

• Set the student's knowledge about the structure and bond in organic compounds.

• Study the different types of representation of organic molecules.

• Apply the general rules of nomenclature for organic compounds.

• Study the stereochemistry of organic compounds and the appropriate nomenclature rules.

• Identify the different functional groups present in organic molecules.

• Study the reactivity of the different functional groups that only contain carbon-heteroatom bonds.

• Study the methods of obtaining these functional groups.

• Study the mechanisms of the most important reactions in which these are involved funcional groups.

• Design synthesis of organic compounds from certain starting products and that involve more than one reaction.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

The study of Organic Chemistry is based on the knowledge acquired in the subjects of General Chemistry I and General Chemistry II.
In the same way, the study of the Organic Chemistry II is based on the knowledge acquired in the Organic Chemistry I.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

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 communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Learn autonomously.
- Demonstrate the ability to adapt to new situations.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Recognise and analyse new problems and plan strategies to solve them.
- Evaluate, interpret and synthesise chemical data and information.
- Recognise and evaluate chemical processes in daily life.
- Develop sustainable and environmentally friendly methods.
- Relate chemistry with other disciplines.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

- 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 (RD 1393/2007) // NO CONTENT (RD 822/2021)

The previous section includes the competences contained in the document VERIFICA.This subject addresses part of the learning results of the matter 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 Organic Chemistry II 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 Organic Chemistry II that contemplate the learning outcomes EUROBACHELOR®
The principal techniques of structural investigations, including spectroscopy	Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8)
The structural features of chemical elements and their compounds, including stereochemistry.	Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and

	synthetic), polymers, colloids and other materials.CE11).
The properties of aliphatic, aromatic, heterocyclic and organometallic compounds.	Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4) Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8).
The nature and behaviour of functional groups in organic molecules	Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4) Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Organic Chemistry II that contemplate the learning outcomes EUROBACHELOR®
Ability to demonstrate knowledge and understanding of the facts, concepts, principles and fundamental theories related to the topics mentioned above.	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry..(CE13).
Ability to apply this knowledge and understanding to the solution of common qualitative and quantitative problems.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). Understand the qualitative and quantitative aspects of chemical problems..(CE24).

COMPETENCES AND COGNITIVE SKILLS RELATED TO THE PRACTICE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Organic Chemistry II that contemplate the learning outcomes EUROBACHELOR®
GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Organic Chemstry II that contemplate the learning outcomes EUROBACHELOR®
Ability to apply practical knowledge to solve problems related to qualitative and quantitative information.	Solve problems effectively..(CG4). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
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).

Interpersonal skills to interact with other people and get involved in team work.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to acquire a special sensitivity for sustainable management of water (SDG 6), raw materials and energy sources (SDG 7), as well as for an environmentally friendly and sustainable development (SDGs 11 , 12, 13, 14 and 15), in addition to being able to design, select and/or develop efficient chemical products, processes and/or analytical methodologies (SDG 7) that minimize their impact on the environment (SDGs 14 and 15), using alternative raw materials and reducing wastes (SDG 11).

DESCRIPTION OF CONTENTS

1. Conjugated compounds and ultraviolet spectroscopy

Stability of conjugated dienes: theory of molecular orbitals. Electrophilic additions to conjugated dienes: allylic carbocations. Kinetic and thermodynamic control of the reactions. The Diels Alder's cycloaddition reaction. Diene polymers: synthetic and natural rubbers. Interpretation of ultraviolet spectra: the effect of conjugation. Conjugation, color and the chemistry of vision

2. Benzene and aromaticity. Aromatic electrophilic substitution

Names and sources of aromatic compounds. Structure and stability of benzene. Aromaticity and the Hückel rule of 4n + 2 electrons. Aromatic ions. Policyclic aromatic compounds. Spectroscopy of aromatic compounds. Electrophilic aromatic substitution reactions: bromination. Other aromatic substitutions Alkylation and acylation of aromatic rings: Friedel-Crafts reaction. The effect of substituents on substituted aromatic rings. An explanation of the effect of substituents. Trisubstituted benzenes: additivity of the effects. Aromatic nucleophilic substitution. Benzynes. Oxidation of aromatic compounds. Reduction of aromatic compounds. Synthesis of polysubstituted benzenes.

3. Hydroxyl functional group: alcohols and phenols

Nomenclature and properties of alcohols and phenols. Alcohols as acids and bases. Formation of alkoxydes. Preparation of alcohols from carbonyl compounds: reduction. Preparation of alcohols from Grignard reagents. Alcohol reactions with strong acids: substitution and elimination processes through alkyl oxonium ions. Transpositions. Transformation of alcohols into alkyl halides by reaction with thionyl chloride and phosphorus tribromide. Oxidation of alcohols. Protection of alcohols. Phenols and their uses. Reactions of phenols. Spectroscopy of alcohols and phenols.

4. Ethers and epoxides. Thioles and sulfurs.

Nomenclature. Structure and physical properties of ethers . Synthesis of ethers from alcohols and mineral acids. Williamson synthesis of ethers. Reactions with strong acids. Claisen transposition of ethers. Cyclic ethers: epoxides. Opening of epoxides. Crown ethers. Thiols and sulfides: physical and chemical properties. Ethers spectroscopy.

5. Aldehydes and ketones: nucleophilic addition reactions

Nomenclature of aldehydes and ketones. Structure of the carbonyl group. Physical properties of aldehydes and ketones. Preparation of aldehydes and ketones from alcohols. Reactivity of the carbonyl group: nucleophilic addition mechanisms. Addition of water to form hydrates. Addition of hydrogen cyanide to give cyanohydrins. Addition of alcohols to form acetals and hemiacetals. Acetals as protective groups. Nucleophilic addition of ammonia and its derivatives. Reactions with organometallic compounds: preparation of alcohols. Reduction of carbonyl compounds: catalytic hydrogenation and reductions with metal hydrides. Deoxygenation of the carbonyl group. Oxidation of aldehydes and ketones. Spectroscopy of aldehydes and ketones.

6. Carboxylic acids and derivatives

Nomenclature of carboxylic acids. Structural and physical properties of carboxylic acids. Acidic and basic nature of carboxylic acids. Preparation of carboxylic acids. Substitution in carboxylic carbon: addition-elimination mechanism. Reactions of carboxylic acids. Nomenclature and properties of carboxylic acid derivatives. Acyl nucleophilic substitution reactions. Alkanoyl halides, anhydrides, esters, amides and nitriles. Relative reactivities and structural characteristics of carboxylic acid derivatives. Preparation of the acid derivatives from the corresponding acids. Chemistry of alkanoyl halides, anhydrides and esters: hydrolysis reactions, reactions with other nucleophiles and reduction reactions. Amides: similarities and differences with the other carboxylic acid derivatives. Reactions of nitriles: hydrolysis, reduction and reaction with organo-metals. Spectroscopy of carboxylic acids and derivatives.

7. Substitution reactions in alfa position of the carbonyl group

Acidity of the hydrogens in alpha of aldehydes and ketones: enolate ions. Keto-enol tautomería. Halogenation in alpha of aldehydes and ketones. Bromination in alpha of carboxylic acids. Enolate formation: alkylation. Aldol condensation. Dehydration of aldoles: synthesis of enonas. Uses of the aldol reaction in synthesis. Crossed aldol condensation. Intramolecular aldol condensation. Condensing of Claisen. Condensing of mixed Claisen. Intramolecular Claisen condensation: Dieckmann reaction. Enoliation of beta-dicarbonyl compounds: estability and reactivity of their enolate anions. Decarboxylation of beta-ketoacids. Malonic synthesis and acetoacetic synthesis.

8. Amines. Other nitrongen-containing compounds

Nomenclature of amines. Structure and physical properties of amines. Acidity and basicity of amines. Formation of amines by alkylation reactions. Quaternary ammonium salts: Hofmann elimination. Synthesis of Gabriel. Synthesis of amines from other nitrogen compounds. Synthesis of amines by reductive amination. Synthesis of amines from carboxylic acid derivatives. Characteristics of aromatic amines. Reactions of arylamines. Other nitrogen-containing functional groups. Amine spectroscopy.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Study and independent work	90,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The subject is designed so that the student is the protagonist of his/her own learning. The subject structure is:

• Theory classes and questions.- Theory lessons will introduce the students to the most fundamental aspects of the subject. The question sessions will be dedicated to the application of the

specific knowledge that students have acquired in theory classes. Students must have previously worked on the questions to be solved. The answers will be discussed in class by both the teacher and the students. The classes should be complemented by personal study time.

• Tutoring.- In them the overall learning process of the students will be evaluated. In the tutorial sessions the professor could entrust written reports to the students. Furthermore, the tutorials will serve to solve any doubts that may have arisen during the classes and guide students on the most convenient work methods.

• Seminars-Talks: The Seminars-Talks will deal with complementary aspects of their formation in Organic Chemistry and will be dedicated to the presentation by a specialist of a relevant topic in current Chemistry. For this task, students will attend the event and answer a questionnaire prepared by the teacher.

EVALUATION

For learning assessment, the teacher can use two modalities. The student must opt for one of them and communicate his choice to the secretary of the department according to the written form available. The student must communicate the prefered modality during the first month of the semester. On behalf of the teacher's programming, the student will be evaluated with the B modality if there is no communication within this first month period.

The minimum global qualification to pass the subject in any modality will be 5 points out of 10.

FIRST CALL

Modality A

Continuous evaluation through the course. In this case, the following sections will be considered:

1. Direct evaluation by the teacher (5%): this evaluation will take into account different aspects, among which include:

Assistance and reasoned and clear participation in the discussions and questions in the class

Progress in the use of the language specific to organic chemistry

Troubleshooting and raising doubts

Critical spirit

2. Tutorials and Seminars (globally 15%): In this section the following aspects will be considered:

Assistance

Content and written presentation of the exercises proposed by the teacher (if applicable).

Rational and clear participation in the discussions.

3. Exams (80%): will be held on the date indicated by the Faculty and will be common to all groups of the subject. It will consist of theoretical and practical questions related to the subject explained during the teaching period. The global passing of the subject will necessarily entail having obtained a minimum score of 5 out of 10 points on the exam.

Modality B

Evaluation with only a written exam on the contents of the subject dealt with in theory classes and tutorials, so that the teacher can thus assess whether the student has acquired the skills and knowledge related to the subject. This exam will be 100% of the overall score.

The exam will be held on the date indicated by the Faculty and will be common to all groups of the subject. In this modality, the teacher may take into account the participation of students in theory classes and tutorials for the final grade.

SECOND CALL

In the second call evaluation for students who have chosen modality A, the grade obtained by the student in the first call for sections 1 and 2 will be maintained but, section 3 will be re-evaluated.

REFERENCES

Basic

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- WADE, L. G. Química Orgánica, 9 Ed., Pearson Prentice Hall, 2017. Disponible en formato electrónico en la biblioteca.
- BRUICE, P. Y. Química Orgánica, 5 Ed., Pearson Prentice Hall, 2008. Disponible en formato papel y electrónico en la biblioteca.
- VOLLHARDT, K. P. C. Química Orgánica Estructura y Función, 5 Ed., Ediciones Omega, 2007. Disponible en formato papel en la biblioteca.
- EGE, S. Química Orgánica. 3 Ed., Editorial Reverté, 2000. Disponible en formato papel en la biblioteca.
- QUIÑOA CABANA, E.; RIGUERA VEGA, R. Nomenclatura y representación de los compuestos orgánicos, McGraw-Hill/Interamericana, 2013. Disponible en formato papel y electrónico en la biblioteca.
- ChemBioOffice Ultra, Perkin Elmer (CambridgeSoft) Amplia selección de aplicaciones y funcionalidades que permite a químicos y biólogos dibujar, formular, modelar y editar estructuras moleculares químicas y biológicas así como simular espectros de RMN de protón y carbono.

Additional

- CLAYDEN, J.; GREEVES, N.; WARREN, S. Organic Chemistry, 2 Ed., Oxford University Press: Oxford, 2012. Disponible en formato papel y electrónico en la biblioteca.
- CLAYDEN, J.; WARREN, S. Solutions manual to accompany Organic Chemistry, 2 Ed., Oxford University Press: Oxford, 2013. Disponible en formato papel en la biblioteca.

- CAREY, F. A.; SUNDBERG, R. J. Advanced Organic Chemistry, 4 Ed., Plenum Press, 2000.
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- PETERSON, W.R. Formulación y Nomenclatura Química Orgánica. Eunibar.