COURSE DATA

DATA SUBJECT

Code: 34205
Name: Organic Chemistry III
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Facultat de Química	3	Second quarter
1929 - Double Degree Program in Physics and Chemistry	Facultat de Física	4	Second quarter
1934 - Double Degree Program in Chemistry-Chemical Engineering	Facultat de Química	4	

SUBJECT-MATTER

Degree	Subject-matter	Character
1110 - Degree in Chemistry	Organic Chemistry	COMPULSORY
1929 - Double Degree Program in Physics and Chemistry	Cuarto Curso (Obligatorio)	COMPULSORY
1934 - Double Degree Program in Chemistry-Chemical Engineering	Cuarto curso	COMPULSORY

COORDINATION

BLAY LLINARES GONZALO

SUMMARY

The subject Organic Chemistry III that is taught in the third year of the Degree in Chemistry is a continuation and deepening of the knowledge acquired in the subjects Organic Chemistry I and II that are taught in the second year of the Degree.

Organic Chemistry is the branch of Chemistry that studies the structure, reactivity and synthesis of carbon compounds. Its study covers the behavior of many millions of chemicals with diverse properties, which constitutes one of the great challenges for teaching this discipline: to show Organic Chemistry as a logical and consistent body of interrelated ideas and not as a mere collection of facts without any connection between them.

The relevance of Organic Chemistry gives an idea of ¿¿the fact that this discipline goes beyond purely academic limits and is an important part of life itself. Lipids, carbohydrates, proteins and nucleic acids, all

essential compounds for life, are organic compounds. So are many substances that facilitate our daily life, such as textile fibers, medicines, antioxidants, etc.

The knowledge of the structure of organic compounds leads to the understanding of their reactivity and, consequently, the understanding of the biological processes in which many organic compounds are involved. Furthermore, the knowledge of the reactivity of organic compounds allowed us to design new synthetic methods and to prepare organic compounds with useful properties but without undesirable side effects. Such syntheses should be carried out in a sustainable manner, that is, with a minimum generation of waste.

The study of the Organic Chemistry III subject is based on the knowledge acquired in the previous subjects of Organic Chemistry I and II and, of course, in the General Chemistry I and II subjects. Based on this knowledge, a systematic study will be carried out on some functional groups that complete those already seen, as well as on different bifunctional organic compounds, including the most representative groups of natural products. This study will be completed, on the one hand, with an introduction to the synthesis design and, on the other, with an introduction to the processes catalysed by transition metals and pericyclic reactions.

The objectives to achieve in this subject can be summarised as follows:

- To identify the different functional groups present in the polyfunctional organic molecules, their relative positions and to understand the interactions between them.
- To study the reactivity and methods to obtain organic compounds containing phosphorus, sulfur and silicon.
- To design simple syntheses of organic compounds from the indicated starting products and involving synthetic sequences of up to 5 stages.
- To study the reactivity and methods to obtain monocyclic and simple bicyclic aromatic compounds with hexagonal heterocyclic ring.
- To study the reactivity and methods to obtain monocyclic and simple bicyclic aromatic compounds with pentagonal heterocyclic ring.
- To know the general aspects and the basic mechanism steps of the processes catalysed by transition metals.
- To know the general aspects and the basic mechanism guidelines of pericyclic reactions.
- To identify the main groups of natural products in primary and secondary metabolism, and to know their importance.

Regarding the Sustainable Development Goals (SDG), 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 (SDG 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).

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

1110 - Degree in Chemistry

Obligation to have previously passed the subject(s)
34183 - General Chemistry I
34184 - General Chemistry II

1929 - Double Degree Program in Physics and Chemistry

Obligation to have previously passed the subject(s)
34183 - General Chemistry I
34184 - General Chemistry II

1934 - Double Degree Program in Chemistry-Chemical Engineering

Obligation to have previously passed the subject(s)
34183 - General Chemistry I
34184 - General Chemistry II

OTHER REQUIREMENTS

The study of Organic Chemistry III is based on the knowledge acquired in Organic Chemistry I and II. The structure and reactivity of the functional groups studied in Organic Chemistry I and II is important to understand the more complex systems that will be studied here. To strengthen the knowledge of the nomenclature and the representation of organic compounds, including their configurations and conformations is also essential.

COMPETENCES / LEARNING OUTCOMES

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Act autonomously in learning, making well-founded decisions in various contexts, forming judgements based on experimentation and analysis, and applying knowledge to new situations.

Address new problems and propose strategies to solve them.

Collaborate effectively in work teams, assume responsibilities and leadership roles, and contribute to collective improvement and development.

Communicate effectively both orally and in writing, adapting to the context and audience.

Contribute to the design, development and implementation of solutions that respond to social demands, using the Sustainable Development Goals as a reference.

Demonstrate both inductive and deductive reasoning skills.

Demonstrate critical and self-critical thinking, considering professional ethics, moral values and social implications of the different activities carried out throughout the degree.

Demonstrate the ability to analyse, synthesise and reason critically.

Distinguish between the qualitative and quantitative aspects of chemical problems.

Distinguish the principles, procedures and techniques used in the determination, separation, identification and characterisation of chemical compounds.

Evaluate the risks involved in the use of chemical substances and laboratory procedures.

Express ideas correctly, both orally and in writing, in any of the official languages of the Valencian

Community.

Identify chemical elements and their compounds, including their extraction, structure, reactivity, properties and applications.

Identify chemical processes in everyday life.

Identify the main types of chemical reactions and their associated key characteristics.

Implement sustainable and environmentally friendly methodologies.

Interpret the relationship between the variation in the characteristic properties of chemical elements and the Periodic Table.

Propose creative and innovative solutions to complex situations or problems in the field, addressing diverse professional and social needs.

Relate chemistry to other disciplines.

Relate theory to experimentation.

Solve problems effectively.

State the principles of thermodynamics and kinetics and their application in chemistry.

Understand and analyse, from the perspective of the degree programme, social inequalities based on sex and gender; integrate gender-sensitive approaches into problem-solving and solution design.

Use chemical terminology, nomenclature, conventions and units correctly.

DESCRIPTION OF CONTENTS

1. Unsaturated carbonyl compounds.

Unsaturated carbonyl compounds. Additional stability of α, β-unsaturated carbonyl compounds regarding unconjugated ones. Reactions of α, β-unsaturated carbonyl compounds: 1,2-addition (direct addition) and 1,4-addition (conjugate addition or addition of Michael). Factors that control the conjugate addition. Reaction conditions: kinetic vs. thermodynamic control. Nature of α, β-unsaturated carbonyl compound. Nature of the nucleophile: hard or soft nucleophiles. Addition of heteroatomic nucleophiles. Conjugated additions of carbon nucleophiles. Addition of organometallic compounds: organolithium, organomagnesians and organocuprates. Vinology principle. Conjugate substitution reactions. Nucleophilic epoxidation. Addition of enolate anions. Robinsons anellation reaction. Conjugated reactions of other electronically deficient alkenes.

Properties, preparation and reactivity of the main organic functions with phosphorus: phosphines and salts

2. Sulfur, silicon and phosphorus compounds.

of phosphonium, phosphates and phosphonates. Phosphorus Ilures. Wittig olefination reaction and related reactions. Properties, preparation and reactivity of the main organic functions with sulfur: thioalcohols and thioethers, sulfoxides and sulphones, and sulfonic acids. Anions stabilized by sulfur: sulfur ylides. Sulfoxide elimination reactions. Julia olefination reaction. Properties, preparation and reactivity of the main organic functions with silicon. Nucleophilic substitution on silicon. Protective groups based on silicon. Stabilisation of carbaniones by silicon. Olephination reaction of Peterson. Stabilisation of carbocations by silicon. Reactivity of aryl silanes, vinyl silanes and allyl silanes. Synthetic applications.

3. Retrosynthetic analysis.

Retrosynthetic disconnection. Synthon concept: idealised reagents. Fundamental strategies of disconnection. Disconnections CHeteroatom. Synthesis of several stages: the problem of chemoselectivity. Protection of functional groups. Interconversion of functional groups. Disconnections involving two functional groups: 1,2 disconnections, 1,3 disconnections. CC disconnections: CC 1,1 disconnections, CC 1,2 disconnections. Giving and accepting synthons. CC disconnections of two functional groups: 1,3-difunctionalised compounds, 1,5-difunctionalised compounds. Natural reactivity and umpolung.

4. Aromatic heterocyclic compounds: structure and reactivity.

Types of heterocyclic compounds. Nomenclature of heterocyclic compounds. Relevant saturated and aromatic heterocycles. Aromatic heterocycles of six links: pyridine. Reactivity of pyridine: reactions of pyridine nitrogen, reactions by carbonate positions. Derivatives of pyridine: pyridones, N-pyridine oxides. Aromatic heterocycles of six links with more than one heteroatom: diazines. Aromatic heterocycles of five links: pyrrole, furan and thiophene. Reactivity of pentagonal heterocycles. Heterocycles of five members with more than one nitrogen atom: azoles. Benzofused heterocycles. Benzopyridines: quinoline and isoquinoline. Five-member heterocycles fused to benzene: indole.
Main approaches for the synthesis of aromatic heterocycles: modification of existing rings, construction of the heterocyclic ring by ionic reactions, construction of the heterocyclic ring by cycloadditions. Retrosynthetic analysis in the synthesis of heterocycles: disconnection of carbon-heteroatom bonds. Pyrroles, thiophenes and furans from 1,4-dicarbonyl compounds. Hantzsch synthesis of pyridines. Other synthesis of pyridines: Synthesis of Guareschi. Synthesis of pyrazoles and pyridazines from dicarbonyl compounds and hydrazine. Synthesis of pyrimidines from 1,3-dicarbonyl compounds and amidines. Azole synthesis. Synthesis of quinolines and isoquinolines. The synthesis of Fischer indoles.

Organometalic compounds of transition metals: general aspects, hapticity. The rule of the 18 electrons. Bonding in transition metal complexes. Basic mechanistic guidelines for organometallic complexes. Exchange of ligands. Oxidising addition and reductive elimination. Migratory insertion. Transmetallation. Transition metals in organic synthesis: catalytic processes. Reactions of palladium organometallics. Reactions through σ complexes: coupling reactions of halides with alkenes (Heck reactions) and alkynes (Sonogashira reaction); Reactions of coupling of halides with organometallic (reactions of Negishi, Suzuki and Stille); Reactions of coupling with amines (Buchwald-Hartwig reactions). Reactions through π

5. Organometallic transition metals reagents.

complexes: nucleophilic addition to alkene-palladium complexes (Wacker reaction). Reactions through π-allyl complexes: nucleophilic addition to η3-allyl palladium complexes (allylic substitution reactions). Reactions through acyl-palladium complexes: carbonylation reactions.

6. Pericyclic reactions

Ionic vs. pericyclic reactions. Molecular orbitals of conjugated π systems. Control of pericyclic reactions by Frontier Molecular Orbitals. Electrocyclic reactions. Stereochemistry of electrocyclic thermal reactions. Electrocyclic photochemical reactions. Cycloaddition reactions: cycloadditions [2+2] and [4+2]. Stereochemistry of cycloaddition reactions. Sigmatropic rearrangements. Some examples of sigmatropic rearrangements. Summary of the rules for pericyclic reactions.

7. Natural Products

Introduction: primary and secondary metabolites. Primary metabolites: Carbohydrates. Classification. Monosaccharides and representation of the stereochemistry. Cyclic structures of monosaccharides. Structure of glucose. Anomeric carbon and glycosidic bond. Disaccharides and polysaccharides. Amino acids. Peptides and proteins. Peptide synthesis. Structure of proteins. Enzymes and co-enzymes. Nucleic acids: Composition and structure. Secondary metabolites: Waxes, fats and oils. Soaps. Prostaglandins. Terpenes. Steroids.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	9,00
Theory	51,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	90,00
Preparation of lessons	0,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**90,00**

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

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

FIRST CALL

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 mínimum score of 5 out of 10 points on the exam.

SECOND CALL

In the second call evaluation, 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.

Final warning

Copying or plagiarism of any assignment that is part of the evaluation will make it impossible to pass the course, and the student will be subject to the appropriate disciplinary procedures.

Please note that, according to Article 13 d) of the University Student Statute (RD 1791/2010, December 30), "*it is the duty of a student to refrain from using or cooperating in fraudulent procedures in evaluation tests, in the work performed or in official University documents*".

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