Bachelor´s Degree in Chemistry

Subject Guide

1. Information about the subject

SUBJECT	Organic Chemistry I	**CODE**	GQUIMI01-2-007
EDUCATIONAL OFFER	Bachelor´s Degree in Chemistry	**CENTER**	Facultad de Química
TYPE	Compulsory	**N° TOTAL CREDITS**	12.0
PERIOD	Annual	**LANGUAGE**	Spanish

COORDINATORS/ES	**EMAIL**
Flórez González Josefa	jflorezg@uniovi.es

LECTURERS	**EMAIL**	
Ferrero Fuertes Miguel	mferrero@uniovi.es	
Fernández González Susana	fernandezgsusana@uniovi.es	
RUBIO ROYO EDUARDO	erubio@uniovi.es	(English Group)
Flórez González Josefa	jflorezg@uniovi.es	
VALDES GOMEZ ALFONSO CARLOS	acvg@uniovi.es	(English Group)

2. Context

1. Course Identifying Details: **ORGANIC CHEMISTRY I**

Course Name	**ORGANIC CHEMISTRY I**							CODE	GQUIMI01-3-007		
Degree	**B.A.**				LOCATION	**FACULTY OF CHEMISTRY**					
Course Type	**Core**		CREDIT ALLOTMENT				**12**				
SEMESTER	**1 and 2**			LANGUAGE		**English**					
INSTRUCTORS					PHONE /EMAIL					OFFICE	
Eduardo Rubio Royo					985102979/ erubio@uniovi.es					**332**	
Carlos Valdés Gómez					985103505/acvg@uniovi.es					**337**	

2. Course General Description

Organic Chemistry I is a core course in the Basic Module “Organic Chemistry” that is given, in a year-long term in the course 2 from the degree

in chemistry. It is lectured by instructors from the Department of Organic and Inorganic Chemistry. It is a compulsory prerequisite to take the courses “Experimentation in Organic Chemistry 1” and “Organic Chemistry II”.

The first semester, the instructor for CEXs, PAs and TGs will be Eduardo Rubio

The second semester, the instructor for CEXs, PAs and TGs will be Carlos Valdés

Organic Chemistry I provides the basic grounds required to study the rest of courses of the area of organic chemistry, as well as for the other areas of chemistry (inorganic, physical and analytical chemistry)

The course has different goals:

- Complete the basic chemical knowledge acquired in year 1
- Apply the basic chemical concepts to organic chemistry
- Know the different types of compounds and fundamental reactions in organic chemistry
- Provide the student with the skills required to study the rest of organic chemistry topics

3. Requirements

As for the rest of courses in the module, it will be mandatory to have passed the basic general chemistry subjects (topics: General Chemistry; Basic Laboratory Operations and Information Technology Tools).

4. Competencies and learning results

4. Course Objectives and Learning Outcomes.

4.1.- General Objectives:

(CG-1) Rationalization and analysis abilities.

(CG-2) Being capable of effectively solving specific problems

(CG-4) Planning and Organizing abilities

(CG-5) Decision making abilities

(CG-6) Manage information properly

(CG-7) Use of english (oral and writing abilities)

(CG-9) Self-learning abilities

(CG-12) Have environmental conscience

(CG-17) Develop critical thinking

4.2.- Specific Obejectives:

(CE-1) Acquire the grounds of chemical terminology, naming, conventions and units.

(CE-2) Relate macroscopic properties with those of atoms and individual molecules

(CE-5) Describe the types of chemical reactions and their related characteristics

(CE-7) Apply the principles of thermodynamics and their implications in chemistry.

(CE-8) Learn the kinetics of chemical changes including catalysis and mechanisms of reaction.

(CE-10) Recognize the nature and behavior of functional groups in organic molecules as well as the main synthetic pathways in organic chemistry.

(CE-11) Infer the properties of organic and organometallic compounds.

(CE-19) Demonstrate knowledge and understanding of the essential facts, principles and theories related to chemistry.

(CE-20) Solve quantitative and qualitative problems applying mathematic models.

(CE-22) Acquire skills to evaluate, interpret and analyze chemical information.

(CE-33) Recognize and evaluate chemical processes in daily life.

4.3.- Learning.

- Consult and use the scientific information in an efficient manner
- Recognize and analyze new problems in organic chemistry and devise strategies aimed to solve them
- Show knowledge and understanding facts, concepts, principles and theories related to organic chemistry and their application to solve problems. Specifically, the student should know :

1. The chemical bond in organic molecules, the relationship between structure and physical properties, acidity and basicity
2. The basic terminology of organic chemistry, how to express ideas precisely and be able to establish relations among different concepts
3. The basis of Thermodynamics and Kinetics and their applications to organic chemistry
4. The functional groups, their characteristics, the structure/reactivity relationship and the main types of organic reactions
5. The possibilities that organic chemistry offers for planning simple organic synthesis sequences

5. Contents

5. Course contents.

The course is divided in the following units:

Unit 1. Structure and bonding in organic molecules

The scope of Organic Chemistry. Lewis structures and resonance forms. Atomic orbitals and molecular orbitals. Hybrid orbitals. Empirical and

molecular formulas.

Unit 2. Structure and reactivity

Kinetics and thermodynamics of simple chemical processes. Acids and bases; electrophiles and nucleophiles. Functional Groups: centers of reactivity.

Unit 3. Alkanes

Naming, structural and physical properties. Conformational analysis. Cycloalkanes: names and physical properties. Ring strain and structure of cycloalkanes. Conformational analysis. Polycyclic alkanes. Reactions of alkanes. Strength of alkane bonds: radicals. Pyrolysis reactions. Halogenation of methane. Halogenation of higher alkanes: reactivity and selectivity. Synthetic aspects of radical halogenation. Combustion reaction.

Unit 4. Stereoisomers

Introduction. Chirality. Optical activity. Absolute Configuration: R-S sequence rules. Fischer projections. Molecules incorporating several stereocenters: diastereoisomers and *meso* compounds. Stereochemistry in Chemical Reactions. Resolution: separation of enantiomers.

Unit 5. Haloalkanes

Naming and physical properties. Nucleophilic substitution reactions. Reaction mechanism of the SN2 nucleophilic substitution. Stereochemistry. Effects of nucleophile, leaving group, solvent and substrate. Solvolysis of haloalkanes. Effects of solvent, leaving group and nucleophile. SN1

reaction: carbocation stability. Elimination reactions E1 and E2: characteristics and mechanism. Competition between unimolecular and bimolecular processes. Competition between nucleophilic substitution and elimination.

Unit 6. Nuclear Magnetic Resonance Spectroscopy: structural determination technique

Defining Spectroscopy. 1H Nuclear Magnetic Resonance. Chemical shift. Spin-spin splitting. 13C Nuclear Magnetic Resonance.

Unit 7. Alcohols and Ethers

Naming. Structural and physical properties. Acids and bases properties. Synthesis of alcohols by nucleophilic substitution. Synthesis of alcohols: oxidation-reduction relation between alcohols and carbonyl compounds. Organometallic reagents: sources of nucleophilic carbon for alcohol synthesis. Organometallic reagents in the synthesis of alcohols. Complex alcohols: an introduction to synthetic strategies. Reactions of alcohols with base: preparation of alkoxides. Reactions of alcohols with strong acids: alkyloxonium ions in substitution and elimination reactions. Carbocation rearrangements. Organic and Inorganic esters from alcohols. Names and physical properties of ethers. Williamson ether synthesis. Synthesis of ethers from alcohols and mineral acids. Oxacyclopropanes: synthesis and reactivity.

Unit 8. Alkenes; Infrared Spectroscopy and Mass Spectrometry

Naming. Structure and bonding in ethene: the pi bond. Physical properties of alkenes. Infrared spectroscopy. Mass spectrometry. Relative stability of alkenes. Synthesis of alkenes: elimination reactions. Catalytic hydrogenation. Electrophilic addition reactions: hydrohalogenation, hydration, halogenation, oxymercuration-demercuration. Hydroboration-oxidation reactions. Oxidation reactions: epoxidation, dihydroxilation and ozonolysis. Radical addition reactions. Other reactions of alkenes.

Unit 9. Alkynes

Naming. Structure and properties of alkynes. Synthesis of alkynes: double elimination reactions and alkylation from alkynyl anions. Reduction of alkynes. Addition reactions of alkynes.

Unit 10. Delocalized pi systems: Ultraviolet and Visible Spectroscopy

Structure of allyl system: resonance. Radical allylic halogenation. Nucleophilic substitution of allylic systems. Two neighboring double bonds: conjugated dienes. Electrophilic addition on conjugated dienes: kinetic and thermodynamic control. Diels-Alder cycloaddition. Electrocyclic reactions. Electronic spectra: ultraviolet and visible spectroscopy.

Unit 11. Aromatic Hydrocarbons

Naming. Electronic structure. Aromaticity: resonance energy. Hückel´s rule. Electrophilic aromatic substitution reactions. Electrophilic substitution on benzene derivatives: substituents control rate and regioselectivity. Nucleophilic aromatic substitution: benzyne intermediate. Polycyclic aromatic hydrocarbons: naphthalene and anthracene. Alkylbenzenes reactivity.

Unit 12. Aldehydes and Ketones

Naming, structure and properties of the carbonyl group. Synthesis of aldehydes and ketones. Reactivity of carbonyl group: mechanism of nucleophilic addition. Acetals as protecting groups. Wittig reaction. Deoxygenation of the carbonyl group. Baeyer-Villiger oxidation reaction. Acidity of aldehydes and ketones: enolate ions. Keto-enol equilibria: halogenation and alkylation reactions. Aldol condensation: a,b-unsaturated

aldehydes and ketones. Conjugated addition reactions: Michael addition. Robinson annulation.

Unit 13. Carboxylic Acids

Naming, structure and properties of carboxylic acids. Preparation of carboxylic acids: synthesis in industry and in the laboratory. Reactivity of the carboxylic group: addition-elimination mechanism. Carboxylic acid derivatives: naming and synthesis of alkanoyl halides, carboxylic anhydrides, esters and amides. Reduction of carboxylic acids. The Hell-Volhard-Zelinsky reaction.

Unit 14. Reactivities of Carboxylic Acid Derivatives.

Relative reactivities, structures, and spectra of carboxylic acid derivatives. Chemistry of alkanoyl halides. Chemistry of carboxylic anhydrides. Chemistry of esters. Chemistry of amides. Alkanenitriles: a special class of carboxylic acid derivatives.

Unit 15. Amines and their derivatives

Naming, structure and properties of amines. Synthesis of amines. Quaternary ammonium salts: Hofmann elimination reaction. Mannich reaction: alkylation of enols by iminium ions. Nitrosation of amines: diazonium salts. Electrophilic substitution with arenediazonium salts: diazo coupling.

Unit 16. Dicarbonyl and hydroxycarbonyl compounds

1,3-dicarbonyl compounds: Claisen condensation. 1,3-dicarbonyl compounds as synthetic intermediates. 1,2-dicarbonyl compounds and a-

hydroxyketones: alkanoyl (acyl) anion equivalents, benzoin and acyloin condensation.

6. Methodology and working plan

6. Methodology and work plan

In lectures, the instructor will present and discuss the different subjects in detailed manner.

Periodical sets of problems will be handled to students. Students are encouraged to work in and out of class to solve the sets of problems that will be discussed at the seminars/practical classes.

Presentations, slides and questions will be available to students on the eCampus: https://www.innova.uniovi.es/innova/aulanet/aulanet.php

The following table shows the dedication of a student to this course:

Modes		**Hours**	**%**	**Totals**
In-class work	*Lectures*	**84**	**28**	**112**
	Classroom practices /Seminars/ Workshop	**14**	**4,6**	
	Laboratory work /field worko /informatic classroom / languages classroom	**0**		
	Clinic and hospital practices	**0**		
	Group tutorials	**8**	**2,7**	

	Exams and evaluation activities	**6**	**2**	
Out-of-class work	Team work			**188**
	Personal work	**188**	**62,7**	
	Total	**300**		

At the TGs different tasks, previously handled to the students, will be solved. TGs will not be the subject of evaluation.

7. Evaluation of the student's learning results

7. Evaluation and assessment

Organic chemistry I is a core subject from the Fundamental Module. There will be **two midterms** and a **final exam** during the course.

The midterm and the final exams will be held at the end of each semester, during the official exam periods set by the Board of the Faculty.

The final mark will be obtained according to the following criteria:

-REGULAR CALL

Option A: Continuous Evaluation

The final mark will result from the marks obtained in the midterm exams, each accounting to 50% of the final mark. Marks in midterm exams should be equal to or greater than 4.0. A final mark of 5.0 at least is required to pass the course.

Option B: Final Exam

Students not succeeding with option A, will have to pass a final exam. The mark of this exam will be the final mark for the course. A final mark of 5.0 at least is required to pass the course.

To pass the course students must obtain an overall rating **equal to or greater than 5.**

Option C:

Students failing to obtain a mark of 4 in one of the midterm exams but with a mark equal to or higher than 5 in the other one will be allowed to choose between taking the final exam or resit the failed midterm. In this case, students should communicate their decision at the date set for the final exam.

If opting for resitting the failed midterm exam, the final mark would be calculated as mentioned before.

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-EXTRAORDINARY CALLS

- The final mark in the extraordinary calls will be the one obtained in the exam (test score: 100%). To pass the course students must obtain an overall rating **equal to or greater than 5.**

8. Resources, bibliography and complementary documentation

8. Resources, Bibliography and Supporting Documentation

Recommended textbook for a good following up of the subject:

“Organic Chemistry: Structure and Function”, 7th Edition, K. P. C. Vollhardt, N. E. Schore, W.H. Freeman and Company, 2014

Similar textbooks also adequated to follow the course:

“Organic Chemistry”, 3rd Edition, D. Klein, Wiley, 2016

“Organic Chemistry”, 9th Edition, L. G. Wade, Jr., J. W. Simak, Pearson, 2017.

“Organic Chemistry as a Second Language” 4th Edition, D. Klein, Wiley, 2016.

For specific information related to the spectroscopic techniques covered along the course:

“Introduction to Spectroscopy”, 4th Edtion, D. L. Pavia, G. M. Lampman, G. S. Kriz, J. R. Vyvyan, Brooks/Cole Cengage Learning, 2009.