UAB Universitat Autònoma de Barcelona

Structure and Reactivity of Organic Compounds

Code: 102528
ECTS Credits: 12

2025/2026

Degree	Type	Year
Chemistry	OB	2

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

It is necessary to have passed the first-year subjects of the Chemistry Degree:

Fonaments de Química I

Experimentació i Recursos Informàtics

Objectives and Contextualisation

The proposed program aims to provide a general overview of organic compounds, both from a structural perspective and in terms of their reactivity.
In general terms, the course is organized around the common and differential reactivity of the various functional groups. The stereochemical aspects of organic molecules will also be addressed.

The specific objectives are:

1. Study of conformational analysis and stereochemistry of organic molecules.

2. Study of the structure and reactivity of the main functional groups.

3. Study of synthetic methodologies for carbon-carbon bond formation and interconversion of functional groups.

4. Introduction to the mechanisms of organic reactions.

5. Learning basic techniques and experimental procedures of an Organic Chemistry laboratory.

Competences

- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Be ethically committed.
- Communicate orally and in writing in one's own language.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.
- Handle chemical products safely.
- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- Have numerical calculation skills.
- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Learn autonomously.
- Manage, analyse and synthesise information.
- Manage the organisation and planning of tasks.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show initiative and an enterprising spirit.
- Show motivation for quality.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Apply the acquired theoretical contents to the explanation of experimental phenomena.
3. Be ethically committed.
4. Carry out basic synthesis, separation and purification procedures in an organic chemistry laboratory.
5. Communicate orally and in writing in one's own language.
6. Critically evaluate experimental results and deduce their meaning.
7. Describe the different types of isomerism in organic compounds.
8. Describe the mechanisms of the principal organic reactions and the various factors that affect them.
9. Describe the most relevant synthetic methodologies for the inter-conversion of functional groups and the formation of simple and multiple carbon-carbon bonds.
10. Determine and represent the configuration of chiral centres in organic compounds.
11. Have numerical calculation skills.
12. Identify the basic reactivity associated with the various functional organic groups.
13. Identify the functional groups of the principal natural organic products and their most important reactions.

14. Identify the isometric relationship between different structures of organic compounds.
15. Identify the risks in the handling of organic chemical compounds in the laboratory, and apply the suitable protocols for the storage or elimination of the waste generated.
16. Justify the results obtained in the laboratory for the processes of synthesis, separation, purification and characterisation of organic compounds.
17. Learn autonomously.
18. Manage, analyse and synthesise information.
19. Manage the organisation and planning of tasks.
20. Obtain information, including by digital means.
21. Predict the reactivity of different organic functional groups under certain reaction conditions, as well as the structure of the products obtained.
22. Properly handle glass and other common materials in an organic chemistry laboratory.
23. Propose creative ideas and solutions.
24. Propose reaction mechanisms in processes involving organic compounds.
25. Propose simple synthetic methods to obtain certain organic compounds from certain reagents.
26. Reason in a critical manner
27. Recognise the English names of the basic materials and instruments in an organic chemistry laboratory.
28. Resolve organic chemistry problems with the help of the provided complementary bibliography.
29. Resolve problems and make decisions.
30. Safely manipulate chemical reagents and organic compounds.
31. Show initiative and an enterprising spirit.
32. Show motivation for quality.
33. Show sensitivity for environmental issues.
34. Use basic instruments to characterise organic chemical compounds.
35. Use IT to treat and present information.
36. Work in a team and show concern for interpersonal relations at work.

Content

1. Introduction. Basic Concepts in Organic Chemistry

Atomic orbitals, hybrid orbitals, molecular orbitals, and chemical bonding in organic molecules.
Geometry in organic molecules.
Lewis structures and resonance forms.
Oxidation level and oxidation state.
Classification of compounds based on oxidation level. Functional groups.
Thermodynamics and equilibrium: basic concepts in organic reactivity. Enthalpy, entropy, and Gibbs free energy.
Kinetics and reaction mechanisms: elementary reaction and steps in a mechanism, reaction coordinate and profile, transition state, reaction intermediates, catalysis.
Eyring equation (activation free enthalpy) and Arrhenius equation (activation energy).
Organic Nomenclature.

2. Conformational Analysis and Stereochemistry

Introduction to organic compounds. Structural or constitutional isomerism.
Conformational isomerism: representations using Newman projections and sawhorse perspective.
Conformational analysis of alkanes.
Cycloalkanes: ring strain.
Conformational analysis of cyclohexane. Conformational equilibrium in substituted cyclohexanes.
Cis-trans configurational isomerism in cyclic compounds.
Z-E configurational isomerism in alkenes.
Chirality.
Configurational isomerism in compounds with stereogenic centers: representation and R/S nomenclature.
Enantiomerism and diastereomerism.
Optical activity: optical rotation and optical purity.

Configurational isomers with more than one stereogenic center: meso forms.
Racemic mixtures. Resolution of racemates.

3. Radical Substitution Reactions

Halogenation of alkanes.
Bond dissociation energies, free radicals, and relative stability.
Reactivity vs selectivity in alkane halogenation. Hammond postulate.
Radical substitution of allylic, benzylic, and aryl hydrogens.

4. Nucleophilic Substitution on Saturated Carbon

SN1 and SN2 mechanisms and stereochemistry in nucleophilic substitution reactions on saturated carbon.
Leaving groups: alkyl halides, alcohols, and ethers. Effects on reactivity and leaving group activation.
Nucleophiles: acetylide and cyanide; water, alcohols, and thiols; ammonia, amines, and imides. Effects on reactivity.
Other factors influencing reactivity.
Competition between SN1 and SN2 mechanisms.

5. Elimination Reactions

E1 and E2 mechanism reactions for carbon-carbon multiple bond formation.
Leaving groups, substrates, and bases in E1 and E2 mechanisms. Dehydration of alcohols.
Regioselectivity in E1 and E2 reactions. Zaitsev's rule and alkene stability.
Stereochemistry of E1 and E2 mechanisms.
Competition among SN1, SN2, E1, and E2 mechanisms.
Oxidation of alcohols.

6. Addition to Carbon-Carbon Multiple Bonds

Electrophilic addition to alkenes and alkynes: general mechanism.
Addition of hydrogen halides to alkenes. Carbocation intermediates. Markovnikov's rule.
Addition of water and alcohols to alkenes. Carbocation rearrangements.
Oxymercuration-demercuration and hydroboration.
Halogen addition to alkenes.
Hydrogenation of alkenes.
Polymerization of alkenes.
Addition reactions to alkynes.
Conjugated, isolated, and cumulated dienes. Relative stability.
Electrophilic addition to conjugated dienes: 1,2- vs 1,4-addition; kinetic vs thermodynamic control.

7. Nucleophilic Addition to the Carbonyl Group

Reactivity of the carbonyl group. Nucleophilic addition mechanisms.
Addition of carbon nucleophiles: cyanide, acetylides, and organometallic compounds.
Addition of nitrogen nucleophiles.
Addition of oxygen nucleophiles.
Addition of sulfur nucleophiles.
Hydride addition: reduction of aldehydes and ketones.

8. Nucleophilic Substitution at the Acyl Group

Acyl transfer reactions of carboxylic acids and derivatives: addition-elimination mechanism and effects of leaving group and nucleophile.
Interconversion reactions: formation and hydrolysis of carboxylic acid derivatives.
Reduction of acids and derivatives.
Reactions with organometallic compounds.
Phosphoric acid derivatives.
Condensation polymers: functional groups at the 4th oxidation level.

9. Reactivity of the Alpha Carbon in Carbonyl Systems

Acidity of alpha-hydrogens in carbonyl positions. Effect on reactivity.
Keto-enol tautomerism.
Alpha-halogenation of aldehydes and ketones. Alpha-halogenation of carboxylic acids.
Formation of α,β-unsaturated carbonyl products: aldol condensation.
Cannizzaro reaction.
Formation of β-dicarbonyl products: Claisen and Dieckmann condensations.
Reactivity of β-dicarbonyl compounds: acetoacetic and malonic synthesis.

10. Substitution Reactions in Aromatic Compounds

Aromatic compounds: benzene, polycyclic, and heterocyclic systems.
Electrophilic substitution reaction: electrophilic aromatic substitution (EAS) mechanism.
EAS in benzene: nitration, sulfonation, halogenation, Friedel-Crafts acylation and alkylation.
EAS in substituted benzenes: effects on reactivity and orientation.
Diazonium salts. Coupling reactions.
Nucleophilic substitution: nucleophilic aromatic substitution (NAS) mechanism, addition-elimination pathway.
Substituted benzenes from diazonium salts.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	48	1.92	1, 17, 5, 31, 32, 4, 18, 19, 13, 15, 12, 14, 16, 22, 30, 33, 20, 21, 23, 26, 27, 29, 11, 36, 34
Problem classes	20	0.8	1, 17, 5, 7, 8, 9, 10, 18, 13, 12, 14, 20, 21, 23, 24, 25, 26, 29, 11, 36, 35
Seminaires	4	0.16	2, 6, 5, 7, 8, 9, 10, 18, 19, 13, 12, 14, 21, 24, 25, 28, 29
Theoretical classes	58	2.32	1, 17, 5, 7, 8, 9, 10, 18, 13, 12, 14, 3, 33, 20, 21, 24, 25, 26
Type: Autonomous			
Study, problems resolution, practices preparation	158	6.32	

The Virtual Campus will be used to provide students with all the materials that the teaching staff deems necessary for the learning process: course syllabus, lecture presentations, problem sets, links between course content and various recommended textbooks, etc.

Students under both continuous assessment and single assessment modes:

In accordance with the course objectives, students will be required to complete a series of guided learning activities in order to acquire the established knowledge and competencies. These activities will include:

- In-person lectures:
  During part of these sessions, the instructor will highlight selected theoretical aspects of the various course topics. Another part of these classes will take the form of seminars, dedicated to addressing students' questions-whether theoretical content, problem-solving, or course organization matters.

- In-person problem-solving classes:
  These sessions will involve presenting and discussing solutions to a set of problems proposed by the instructor, based on students' independent or group work. Special emphasis will be placed on active student participation.

- Laboratory sessions:
  There will be 12 laboratory sessions, each lasting 4 hours, designed to ensure students acquire basic techniques of an organic synthesis laboratory. The content of these sessions will be tied to the topics covered in prior theoretical classes. Attendance at all 12 sessions is mandatory. There is also a mandatory introductory lab session scheduled.

Note:
During the in-person lectures, several assessment activities ("evidences") will take place throughout the course. Student participation will be encouraged through case resolution and Q&A. These assessment activities will not be mandatory for students enrolled under the single assessment mode.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation of laboratory practices	15%	2	0.08	1, 2, 17, 6, 5, 31, 32, 4, 18, 19, 15, 16, 22, 30, 3, 33, 20, 23, 26, 27, 28, 29, 11, 36, 34, 35
Other evidences	10%	0	0	17, 5, 7, 8, 9, 10, 18, 13, 12, 14, 20, 21, 23, 24, 25, 26, 28, 29, 36, 35
Partial and recovery exams	75%	10	0.4	2, 6, 5, 7, 8, 9, 10, 13, 15, 12, 14, 16, 30, 3, 21, 23, 24, 25, 26, 27, 29

1. EVALUATION

1.1. Students in Continuous Assessment Mode:

The final overall grade for this course will be calculated based on the following three components:

1.1.1. Exams (75% of the final grade):

The exams will assess the knowledge covered in the course syllabus, with particular emphasis on problem-solving skills.

Throughout the course, each midterm exam will include questions on all content covered up to that point. These exams will carry increasing weight in the final exam grade:

- First midterm: Topics 1 to 4; 20% of the final exam grade.
- Second midterm: Topics 1 to 7; 25% of the final exam grade.
- Third midterm: Topics 1 to 10; 30% of the final exam grade.

To pass the course through midterms, students must obtain a minimum score of 4 out of 10 on the third midterm and an average weighted score of 5 out of 10 across the three exams.

1.1.2. Laboratory sessions (15% of the final grade):

Assessment will be based on interest, experimental skills, and results achieved during lab sessions (40%), and the lab exam score (60%).

Lab sessions are mandatory. A maximum of two sessions can be missed due to justified medical reasons. To pass the lab component, students must obtain at least 5 out of 10 in both the lab sessions and the lab exam.

If a student scores below 5 on the lab exam, they must take a retake lab exam on the same day as the retake theory exam. To be eligible, the student must have taken the original lab exam.

SAFETY WARNING: Any student who, due to negligent behavior, causes a serious safety incident may be expelled from the laboratory and fail the course.

Students retaking the course (second enrollment or beyond) who passed the lab component in a previous year under the required conditions do not need to repeatthe labs, and their previous lab grade will be maintained.

1.1.3. Other Evidence (10% of the final grade):

Throughout the course, students may be assigned exercises, quizzes, or other small tasks, to be completed individually or in groups, in class or outside, at the discretion of the instructor.
Any uncompleted assessments will be graded as 0.0 out of 10 when calculating the average.

1.2. Students in Single Assessment Mode:

The final overall grade will be calculated based on the following two components:

1.2.1. Final Exam (85% of the final grade):

The exam will assess the course content, with emphasis on problem-solving skills.
It will be scheduled on the same day as the third midterm for students in the continuous assessment mode.

1.2.2. Laboratory Sessions (15% of the final grade):

The same conditions apply as for students in the continuous assessment mode.

2. TO PASS THE COURSE

2.1. Students in Continuous Assessment Mode:

2.1.1. Conditions:

a) Have a weighted average of at least 5 out of 10 for the three midterms and a minimum of 4 out of 10 in the third midterm. Students taking the retake exam must score at least 5 out of 10 on it.

b) Have attended the lab sessions (as detailed in section 1.1.2) and scored at least 5 out of 10 in both lab components used to calculate the lab grade.

c) Achieve an overall average of at least 5 out of 10 in all graded components.

2.1.2. Retake Exam:

There will be a single retake exam for students who did not pass via midterms. It will cover the entire course content.

Students who passed through coursework may retake the retake exam to improve their grade. In this case:

- If they submit the completed exam, the new score willreplace the average of their midterm grades.
- If they do not submit it, the previously obtained midterm average will be kept.

To take the retake exam, students must have taken at least two of the three midterms.

To pass via the retake exam, students must score at least 5 out of 10. The final grade will be calculated as follows:

- 75% Retake exam
- 10% Other evidence
- 15% Laboratory sessions

If the retake exam is not passed, the maximum final grade (after applying the formula) will be 4.8, meaning the course will be failed.

If a student attends the retake exam but does not submit it, the final grade will revert to the midterm average (a zero will be assigned for any missed midterm).

There will also be a retake lab exam for students who did not score 5 out of 10 in the original lab exam. The 40% related to in-lab performance and results cannot be recovered.

To sit the lab retake exam, students must have taken the original lab exam.
Passing the lab exam is mandatory to pass the course.

2.2. Students in Single Assessment Mode:

2.2.1. Conditions:

a) Score at least 5 out of 10 on the final exam.
b) Attend all lab sessions and obtain a minimum of 5 out of 10 in both the overall lab grade and its two individual components.
c) Achieve an overall average of at least 5 out of 10 in all components.

2.2.2. Retake Exam:

There will be a single retake exam for students in single assessment mode, scheduled on the same day as the continuous assessment retake exam.

Students who passed but wish to improve their grade may take it. If:

- They submit the completed exam, the new score will replace the original final exam grade.
- They do not submit, the original final exam grade will be retained.

The exam will cover all course content.

To pass, a minimum score of 5 out of 10 is required. The final grade will be calculated as:

- 85% Retake exam
- 15% Lab sessions

If the retake exam is not passed, the maximum final grade possible is 4.8, resulting in a course fail.

There will also be a retake lab exam for those who scored below 5 out of 10 on the original lab exam. The 40% for in-lab performance and results is not recoverable.
To take this exam, students must have attempted the original lab exam.
Passing the lab exam is mandatory to pass the course.

3. A STUDENT WILL BE CONSIDERED "NOT ASSESSED" IF:

a) First-time enrollees in continuous assessment mode: Did not take any midterm exams nor the lab sessions.
b) Repeat students in continuous mode with previously passed lab component: Did not take any midterms nor the lab in the current course.
c) First-time enrollees in single assessment mode: Did not take the final exam nor the lab sessions.
d) Repeat students in single assessment mode with previously passed lab: Did not take the final exam nor the lab in the current course.

IMPORTANT NOTICE:

If a student is caught cheating in any assessment, they will receive a score of 0 for that specific test.

Bibliography

Text books:

Organized by reactivity:

Hornback, J. M. (2005). *Organic chemistry* (2nd ed.). Thomson.

Organized by functional groups:

Vollhardt, K. P. C., & Schore, N. E. (2018). *Organic chemistry: structure and function* (Eight edition). Macmillan Education. (Or any other edition)

Bruice, P. Y. (2016). *Essential organic chemistry* (Third, global edition). Pearson. (Or any other edition). Available in electronic format: https://bibcercador.uab.cat/permalink/34CSUC_UAB/1c3utr0/cdi_askewsholts_vlebooks_9781292089058

Nomenclature in Spanish:

Peterson, W. R., & Unió Internacional de Química Pura i Aplicada. (1987). *Formulación y nomenclatura* (11ª ed). EDUNSA.

Websites:

Terms of chemistry dictionary: http://goldbook.iupac.org/

Organic Chemistry Portal:www.organic-chemistry.org

Virtual site of the subject: Moodle

Software

Free software Molecular structure drawing, nomenclature:

http://www.freechemsketch.com/

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan/Spanish	annual	morning-mixed

(PAUL) Classroom practices	2	Catalan/Spanish	annual	afternoon
(PLAB) Practical laboratories	1	Catalan/Spanish	annual	morning-mixed
(PLAB) Practical laboratories	2	Catalan/Spanish	annual	morning-mixed
(PLAB) Practical laboratories	3	Catalan/Spanish	annual	afternoon
(PLAB) Practical laboratories	4	Catalan/Spanish	annual	afternoon
(SEM) Seminars	1	Catalan	annual	morning-mixed
(SEM) Seminars	2	Catalan/Spanish	annual	afternoon
(TE) Theory	1	Catalan	annual	morning-mixed
(TE) Theory	2	Catalan/Spanish	annual	afternoon