



| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                 |           |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        | 2019/20                                         |           |
| Subject (*)         | Advanced Organic Chemistry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Code   |                                                 | 610G01030 |
| Study programme     | Grao en Química                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                 |           |
| Descriptors         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                 |           |
| Cycle               | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Year   | Type                                            | Credits   |
| Graduate            | 1st four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Fourth | Obligatory                                      | 6         |
| Language            | SpanishEnglish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                                                 |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                                                 |           |
| Prerequisites       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                 |           |
| Department          | Química                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                                                 |           |
| Coordinador         | Jimenez Gonzalez, Carlos                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | E-mail | carlos.jimenez@udc.es                           |           |
| Lecturers           | Jimenez Gonzalez, Carlos<br>Sarandeses Da Costa, Luis Alberto                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | E-mail | carlos.jimenez@udc.es<br>luis.sarandeses@udc.es |           |
| Web                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |                                                 |           |
| General description | This main goal of this subject is to provide students a deeper understanding of the synthetic strategies in the modern organic chemistry today, with special focus on aspects related to the stereochemical evolution of organic reactions. Therefore, new concepts in the study of stereochemistry of organic compounds and their reactions will be discussed, the fundamental aspects of the analysis Retrosynthetic and general strategies of organic synthesis. Particularly will be the main types of organic reactions in the carbon-carbon and carbon-heteroatom bond formation. Some advanced techniques in the laboratory of Organic Chemistry will be also studied |        |                                                 |           |

| Study programme competences |                                                                                                                                         |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Code                        | Study programme competences                                                                                                             |
| A1                          | Ability to use chemistry terminology, nomenclature, conventions and units                                                               |
| A4                          | Knowledge of main types of chemical reaction and characteristics of each                                                                |
| A6                          | Knowledge of chemical elements and their compounds, synthesis, structure, properties and reactivity                                     |
| A9                          | Knowledge of structural characteristics of chemical and stereochemical compounds, and basic methods of structural analysis and research |
| A10                         | Knowledge of chemical kinetics, catalysis and reaction mechanisms                                                                       |
| A14                         | Ability to demonstrate knowledge and understanding of concepts, principles and theories in chemistry                                    |
| A15                         | Ability to recognise and analyse new problems and develop solution strategies                                                           |
| A17                         | Ability to work safely in a chemistry laboratory (handling of materials, disposal of waste)                                             |
| A19                         | Ability to follow standard procedures and handle scientific equipment                                                                   |
| A20                         | Ability to interpret data resulting from laboratory observation and measurement                                                         |
| A21                         | Understanding of qualitative and quantitative aspects of chemical problems                                                              |
| A26                         | Ability to follow standard laboratory procedures in relation to analysis and synthesis of organic and inorganic systems                 |
| B2                          | Effective problem solving                                                                                                               |
| B3                          | Application of logical, critical, creative thinking                                                                                     |
| B4                          | Working independently on own initiative                                                                                                 |
| C1                          | Ability to express oneself accurately in the official languages of Galicia (oral and in written)                                        |

| Learning outcomes                                                                                                      |  |                             |          |
|------------------------------------------------------------------------------------------------------------------------|--|-----------------------------|----------|
| Learning outcomes                                                                                                      |  | Study programme competences |          |
| Further knowledge of the most important principles of stereochemistry and conformational analysis of organic compounds |  | A1<br>A9                    | B2<br>C1 |
| Be able to predict and explain the stereochemistry evolution of chemical reactions                                     |  | A1<br>A9                    |          |



|                                                                                                                                                        |                                      |                |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------|----|
| Possess knowledge of the main features, the main explanatory theories and mechanisms of the main reactions of C-C bond and C-heteroatom bond formation | A1<br>A4<br>A10<br>A14<br>A15<br>A21 | B2             | C1 |
| Possess knowledge of the interconversion methods of the main functional groups                                                                         | A1<br>A4<br>A6<br>A14                | B2<br>B3       |    |
| Possess knowledge of the main objectives in organic synthesis, the main strategies of synthesis and the retrosynthetic analysis                        | A1<br>A4<br>A14                      | B2             |    |
| Possess knowledge of some advanced techniques in the research laboratory of Organic Chemistry                                                          | A17<br>A19<br>A20<br>A26             | B2<br>B3<br>B4 |    |

| Contents                                                                |                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                                   | Sub-topic                                                                                                                                                                                                                                                                        |
| Chapter 1. Stereochemistry and conformational analysis                  | Static and dynamic stereochemistry. Stereoselective and stereospecific chemical reactions (chemo-, regio- and stereoselective/specific reactions).<br>Conformational analysis: conformational effects on reactivity.                                                             |
| Chapter 2. Pericyclic reactions                                         | Introduction: characteristics of pericyclic reactions and theoretical approaches.<br>Electrocyclic, Cycloaddition reactions and sigmatropic rearrangements.                                                                                                                      |
| Chapter 3. Free-Radical reactions                                       | Generation and stability of free radicals. Main free-radical reactions.                                                                                                                                                                                                          |
| Chapter 4. Generation of carbon-carbon bond by enols and enolates.      | Alkylation, acylation and conjugate addition of enols and enolates                                                                                                                                                                                                               |
| Chapter 5. Generation of carbon-carbon bond by organometallic compounds | Organometallic reagents to make carbon-carbon bonds. Reactions involving transition metal complexes.                                                                                                                                                                             |
| Chapter 6. Generation of carbon- heteroatom bonds                       | Generation of carbon and oxygen, nitrogen, halide and sulfur bonds.                                                                                                                                                                                                              |
| Chapter 7. Functional group interconversion reactions.                  | Main Functional group interconversion reactions Functional group interconversions through reduction and oxidation reactions.                                                                                                                                                     |
| Chapter 8. Protective groups in organic synthesis                       | The role of protective groups in organic synthesis. The concept of orthogonal sets.<br>Hydroxyl, diols, aldehyde and ketone carbonyl, carboxylic acid and amine protecting groups.                                                                                               |
| Chapter 9. Retrosynthetic analysis.                                     | Synthetic analysis and planning. Retrosynthetic analysis methodology. Types of transformations: disconnections, connections, functional group interconversion, addition and removing functional groups. Economic issues in retrosynthetic analysis.<br>Illustrative synthesis. s |

| Planning                       |                     |                      |                               |             |
|--------------------------------|---------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests          | Competencies        | Ordinary class hours | Student?s personal work hours | Total hours |
| Introductory activities        | A14                 | 1                    | 0                             | 1           |
| Guest lecture / keynote speech | A1 A4 A6 A9 A10 A14 | 25                   | 62.5                          | 87.5        |
| Problem solving                | A15 A21 B2 B3 B4 C1 | 9                    | 18                            | 27          |
| Laboratory practice            | A17 A19 A20 A26     | 10                   | 15                            | 25          |



|                                                                                                                                 |                                 |     |   |     |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------|-----|---|-----|
| Mixed objective/subjective test                                                                                                 | A1 A4 A6 A9 A10 A14<br>B2 B3 C1 | 4   | 4 | 8   |
| Personalized attention                                                                                                          |                                 | 1.5 | 0 | 1.5 |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                                 |     |   |     |

| Methodologies                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Introductory activities         | An introduction to the subject will be presented to the students where the tasks to be performed along the course and the methodologies, assessment methods and the most relevant literature will be explained. It will be held the first day.                                                                                                                                                                                                                                                                                                                         |
| Guest lecture / keynote speech  | It is planned to carry out 25 sessions of lectures in one group where the theoretical contents of the subject together with relevant illustrative examples will be presented. It will consist mainly of Power Point presentations. Students will have copies of all the presentations via the Moodle application, so that students can prepare them before classes. Interactive student participation will be encouraged at all times.                                                                                                                                 |
| Problem solving                 | It is planned to carry out 9 problem seminar sessions in small groups where students will solve the problems elaborated by the teacher. Students will have in advance notice of such problems through the Moodle application. These seminars will also be used to solve any doubts that arise during the theoretical classes                                                                                                                                                                                                                                           |
| Laboratory practice             | It is planned to carry out three experimental working sessions in which students will have to perform the experiments scheduled. The students will have the procedure and information about such experiments in advance through the Moodle application, so that they can prepare them before the start of the experiment at the laboratory. The student will have to demonstrate the know-how of the experiment before entering the laboratory. They have to elaborate a laboratory notebook which has to be given to the teacher at the end of the experimental work. |
| Mixed objective/subjective test | A final exam have to be done by the student on the dates established by the Faculty Board. Additionally, there is no mandatory midterm exam which will be eliminatory, so that students who pass this test does not need to be tested by that part at the final exam. The aim of these exams will be evaluate the knowledge and skills acquired by students.                                                                                                                                                                                                           |

| Personalized attention                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Problem solving<br>Laboratory practice | <p>This activity will mainly focus on resolving the doubts that may arise when students are trying to solve individually the problems. It will take place in the timetable of tutorials available to the teacher.</p> <p>In addition, this personalized attention will take place in interviews that the student has to perform before carrying out the experiments scheduled practices</p> <p>Part-time students or students with special academic permission (according to the rules of the UDC): The same evaluation criteria listed above are applied, but it's not mandatory to attend classroom lectures. It is compulsory to attend laboratory practical sessions. It will be tried to fit the dates to the student's availability.</p> |

| Assessment          |                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |               |
|---------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies       | Competencies        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Qualification |
| Problem solving     | A15 A21 B2 B3 B4 C1 | Student attendance at these seminar classes will be evaluated and their active participation will be assessed by questioning both in the classroom and through email. They will also be evaluated in the resolution of the problems at the seminars.                                                                                                                                                                                                                                                                                                                                      | 15            |
| Laboratory practice | A17 A19 A20 A26     | Firstly, students will be evaluated through a personal interview before they start each experiment. Then the student work at the laboratory will be evaluated from the point of view of organization, management skills to handle all chemicals, equipment and apparatus with care. Finally, the laboratory notebook that student will submit at the end of the experiments will be also evaluated. The attendance and pass these experimental classes are a necessary condition to pass this subject. Attendance at these experimental classes avoids to be considered as not presented. | 15            |



|                                 |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |
|---------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Mixed objective/subjective test | A1 A4 A6 A9 A10 A14<br>B2 B3 C1 | Students will have to solve similar problems in the written exams to those done at the seminar classes. There are two exams: the first one or non compulsory partial exam will take place in about half of semester and the final exam to be held on a fixed date on the calendar established by the Faculty Board. The partial exam is not compulsory and is eliminatory, so that students who pass it, they do not have to be evaluated from this part at the final exam. | 70 |
|---------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|

## Assessment comments

Students must attend all experimental laboratory classes in order to pass this subject.

They must reach at least a 45% for each evaluation items (including both partial exams if the student does not take the global final exam) and they must reach equal to or greater than 5 points average rating. An essential requirement to pass the subject is to pass the experimental laboratory classes.

A student shall be considered ?not presented? when he is not attend the experimental laboratory classes and he is not present at the final exam.

Students will keep the rates from experimental laboratory classes and from the seminars at the second opportunity in July. This new exam will be held on dates determined by the Faculty Board and the qualification will replace the one obtained in January.

Students at the second opportunity may only be eligible for honors if

the maximum number of them for this subject, according to the academic regulations, has not been covered in full at the first opportunity. In the following academic courses, students will have to perform all activities that are scheduled for that course.

The student who has not passed the laboratory practices will have to perform a test in the laboratory where he will perform the repetition of a part that will be indicated by the teacher. He must pass this test as an essential condition to pass the matter in that second opportunity.

Part-time students or students with special academic permission (according to the rules of the UDC): The same evaluation criteria listed above are applied, but it's not mandatory to attend classroom lectures. It is compulsory to attend laboratory practical sessions. It will be tried to fit the dates to the student's availability.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"> <li>- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P., (2012). Organic Chemistry. Oxford, University Press</li> <li>- Ege, S. (1997). Química Orgánica: Estructura y reactividad. Barcelona. Reverté</li> <li>- Carda, M., Marco, J.A., Murga, J., Falomir, E. (2010). Análisis retrosintético y síntesis orgánica. Castellón de la Plana, Universitat Jaume I</li> <li>- Quiroga Feijóo, M. L (2007). Estereoquímica: conceptos y aplicaciones en química orgánica. Madrid, Síntesis</li> <li>- McMurry, J. (2000). Química Orgánica. México. Thomsom</li> <li>- Harwood, L. M.; Moody, C. J.; Percy, J. M. (1999). Experimental Organic Chemistry. Standard and microscale 2º Ed.. Oxford: Blackwell Science</li> </ul> |
| <b>Complementary</b> | <ul style="list-style-type: none"> <li>- Carey, F. A.; Sundberg, R. J. (2007). Advanced Organic Chemistry 5º Edición. New York: Springer</li> <li>- Smith, M. B.; March, J (2007). March's Advanced Organic Chemistry 6º Ed.. New York: Wiley</li> <li>- Norman, R. O. C.; Coxon, J. M. (1993 (2001 imp.)). Principles of Organic Synthesis. Cheltenham (RU): Nelson Thornes</li> <li>- Carda, M., Rodríguez, S., González, F., Murga, J., Falomir, E., Castillo, E. (1996). Síntesis Orgánica. Resolución de problemas por el método de la desconexión. Castellón de la Plana: Universitat Jaume I</li> <li>- Eliel, E. L., Wilen, S.H. (1994). Stereochemistry of organic compounds. New York : John Wiley &amp; Sons</li> </ul>                             |

## Recommendations

Subjects that it is recommended to have taken before



Organic Chemistry 1/610G01026

Organic Chemistry 2/610G01027

Intermediate Organic Chemistry/610G01028

Experimental Organic Chemistry/610G01029

Chemistry Laboratory 2/610G01032

Subjects that are recommended to be taken simultaneously

Subjects that continue the syllabus

Medicinal Chemistry/610G01040

Final Dissertation/610G01043

Other comments

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.