Universidad Zaragoza

Academic Year/course: 2024/25

60450 - Synthetic strategies in advanced organic chemistry

Syllabus Information

Academic year: 2024/25
Subject: 60450 - Synthetic strategies in advanced organic chemistry
Faculty / School: 100 - Facultad de Ciencias
Degree: 543 - Master's in Molecular Chemistry and Homogeneous Catalysis
ECTS: 6.0
Year: 1
Semester: First semester
Subject type: Compulsory
Module:

1. General information

This subject is one of the basic pillars of the Master's Degree in Molecular Chemistry and Homogeneous Catalysis. This subject will help the student to learn how to propose synthetic procedures that allow them to prepare new or existing molecules, using the tools provided by organic chemistry, organometallic chemistry and catalysis.

2. Learning results

Upon completion of this subject, the student will be able to:

a) Know the principles of retrosynthetic analysis and how to apply them to the synthesis of a relatively complex organic molecule from readily available starting products.

b) know the usual synthetic procedures to build carbon skeletons in organic molecules (open chains, ring construction, carbon-carbon bond formation), as well as to transform some functional groups into others.

c) Use the principles of synthetic organic chemistry appropriately, taking into account the compatibility and incompatibility between functional groups.

d) Understand and have an integrated vision of the mechanisms of organic reactions to better understand the concepts of chemoselectivity, regioselectivity and stereoselectivity.

e) Solve problems and questions related to organic synthesis.

f) Propose reasonable synthetic procedures for organic compounds of medium complexity, taking into account the stereochemistry at each stage.

g) Analyse different synthetic alternatives for the same compound and defend critically which is the most reasonable.

h) Analyse syntheses described in the scientific literature for complex molecules (natural products and other products of interest).

i) Obtain information from bibliographic sources, organize and analyse it in a critical manner, prepare reports and present the conclusions obtained.

j) Develop experimental protocols for advanced organic synthesis.

3. Syllabus

Topic 1. The basis of retrosynthetic analysis. Retrosynthetic analysis. Methodology. Concept of synthon. Types of transformations.

Topic 2. Csp3-Csp3 single bond formation. Carbanions type d: synthesis via enolates. Leasing. Alkylation of compounds with active methylenes. Alkylation of 1,3-dicarbonyl compounds. Aldolic condensation. Michael-type additions. D-type carbanions: synthesis via organometallics. Organolithium and organomagnesium compounds.

Topic 3. Formation of carbon-carbon multiple bonds. Synthesis of alkenes. Elimination reactions. Condensation reactions of carbonyls with ilides and other carbanions. Synthesis of alkynes. Elimination reactions. Condensation reactions.

Topic 4. Formation of cyclic compounds. Cyclopropanes: addition of carbenes. Cyclopentanes. Cyclohexanes and cyclohexenes: [4+2] cycloadditions. Robinson's annulation. Metal carbene-mediated synthesis, ring-closing metathesis reaction.

Topic 5. Protective groups in synthesis. Protection of hydroxyl groups, carboxylic acids, amino groups and carbonyl groups.

Topic 6. Oxidation and reduction reactions. Oxidation of alcohols. Oxidation of alkenes. Baeyer-Villiger reaction and other oxidations. Catalytic hydrogenation. Hydrogenations in the absence of hydrogen. Reductions with group 13 metal hydrides (B, Al). Reductions with active metals. Deoxygenation of carbonyl groups. Other reductions.

Topic 7. Csp2-Csp2 bond formation. Use of organocuprate compounds in synthesis: substitutions and conjugated additions. Palladium-mediated synthesis. Coupling reactions. Reactions with pi-allyl palladium complexes.

4. Academic activities

The planned academic activities will be conducted in face-to-face mode unless, due to extraordinary situations, they could be adapted to be carried out telematically.

Theoretical classes (3 ECTS). This activity comprises 30 hours of lectures in the classroom using power point slides and explanations on the blackboard.

2. Problem classes and seminars (3 ECTS). This activity comprises 30 hours of face-to-face classes in which students will have to solve and propose solutions to synthesize complex molecules from the given starting products.

5. Assessment system

1. Continuous assessment
During the semester there will be two partial tests, P1 and P2. Students will have to solve the organic synthesis problems proposed in these tests. The dates of these mid-term exams will be announced at the beginning of the term.
The final grade will be obtained by applying the formula:
Final grade = 0.5 x P1 + 0.5 x P2
A minimum grade of 5 (out of 10) must be obtained to pass the subject.

2. Global Test
Students who do not choose the continuous evaluation system, do not pass the subject by this procedure or who want to improve their grade, will have the right to take a global test consisting of a single written exam on organic synthesis problems. A minimum grade of 5 points (out of 10) is required to pass the subject.

The student's final grade will be the best of the grades obtained between the continuous assessment and the global test. The use of molecular models, subject notes or textbooks will be allowed for both the partial exams and the global test.

6. Sustainable Development Goals

3 - Good Health & Well-Being
7 - Affordable and Clean Energy
13 - Climate Action