UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Advanced Organic Chemistry

2425-1-F5401Q019

Aims

Detailed discussion of the main reaction mechanisms of organic molecules. Advanced reactivity of aromatic and heteroaromatic systems. Cyclization reactions.

Knowledge and understanding skills developed

At the end of the course the student knows

- The main theoretical / practical tools to address the mechanistic study of reactions in organic chemistry
- The subdivision of reactions in organic chemistry through the study of the main mechanistic families
- The application of the concepts learned in the course in an advanced laboratory of organic chemistry.

Knowledge and understanding skills applied

- At the end of the course the student has the tools in order to study the organic reactions from a mechanistic point of view, in order to obtain selective regio and stereo reactions
- At the end of the course the student is able to choose the best reaction conditions to optimize the regio and stereo selection of a reaction
- At the end of the course the student is able to work in an advanced organic chemistry laboratory.

Autonomy of judgment

At the end of the course the student is able to evaluate which is the best mechanistic model to develop the study of an organic reaction

Communication skills

- Knowing how to describe the organic reaction mechanism using the correct terminology
- Knowing how to describe in a laboratory notebook an organic reaction carried out in the laboratory using

the correct terminology

Ability to learn

- Apply the knowledge learned during the course to correctly interpret any organic chemistry article

Contents

Elements of eletronic structure of organic materials. Frontier molecular orbitals (FMO) and the Klopman-Salem equation. Mechanisms: thermodynamics and kinetics, thermodynamic and kinetic control of produc composition, acidity and basicity, electrophilicity and nucleophilicity, free-energy relationships, Hammond's postulate, general and specific catalysis). Reactions: nucleophilic substitution, addition, elimination, oxidation and reduction. Reactive species: nucleophiles and electrophiles, carbanions, radicals, addition to carbonyl group. Aromaticity. Aromatic substitution. Pericyclic reactions. Molecular rearrangements.

The lab module is addressed to provide the student with the safety and behavior aspects for conducting correctly an organic chemistry experiment. The experiments carried out in the laboratory are intended to exploit the basic technical operations in organic chemistry to synthesise some organic compounds using multi-step synthetic protocols

Detailed program

Basic mechanistic concept: kinetic versus thermodynamic, Hammond' s postulate, Curtin-Hammett principle, microscopic reversible principle.

Linear correlation structure-reactivity: Hammet equation

Primary kinetic isotopic effect

Acid and bases: Acids stronger tha H3O+, nucleohilic scale: Swain-Scott and Ritchie equations.

Acid catalysis: general and specific catalysis

Nucleophilic substitution: the limiting cases Sn1 e Sn2, borderline mechanism, nucleophilicity and solvent effect, leaving group effect, rearrangements of carbocataion

Polar addition and Elimination reactions, additions of hydrogen halides to alkens, acid-catalyzed hydration, addition of halogens, electrophilic addition involving metal ions, the E1, E2, E1cb, mechanism, stereochemistry of E2 reactions.

Reactions of carbonyl compounds; hydration and addition of alchools to aldehydes and ketons, addition of carbon nucleophiles to carbonyl groups, ester hydrolysis, amide hydrolysis

Aromaticity: the concept of aromaticity, the annulenes, Homoaromacity, fused-ring system, heterocyclic rings.

Aromatic Substitution: Electrophilic Aromatic Substitution, Structure-Reactivity Relationship, reactivity of polyciclic and heteroaromatic compounds. Specific substitution mechanism

Peryciclic Reaction: electrocyclic reaction, sigmatropic rearrangements, cycloaddition reaction,

In the laboratory will be presented the safety rules and behavior to be followed in an organic chemistry laboratory, the main techniques of analysis and purification of organic substances (crystallization, distillation, chromatographic techniques, selective extraction with solvents) and how to handle organic chemistry reactions for the synthesis of molecules obtained as a result of multistep synthesis.

Prerequisites

Knowledge of Organic and Physical chemistry at bachelor level

Teaching form

24 two-hour lectures, in person. Delivered Didactics

2 two-hour lab lectures, in person. Delivered Didactics
5 four-hour lab activities, in person, Interactive Teaching

Teaching language will be italian.

Textbook and teaching resource

F. A. Carey, R.J. Sundberg "*Advanced Organic Chemistry*", Ed. Plenum Press, New York

integral recording of the lessons

annotated slides.

Semester

1 semester

Assessment method

Oral examination aimed at verifying adequate knowledge of: a) the chemical physical basis of mechanisms in organic chemistry b) the main general mechanisms of reaction in organic chemistry c) the capability to plan the synthetic access to simple organic multifuctional molecules.

For the laboratory part, the activity carried out will be evaluated as well as the compilation of the laboratory notebook. Furthermore, two tests relating to the skills acquired to be done during the course on the e-learning platform will complete the evaluation of the laboratory course.

Evaluation Scale:

18-19: Knowledge of a limited number of topics from the course syllabus, with restricted ability in discussion and analysis, which, in the case of an oral exam, emerge only with the help and questions from the instructor; expository skills and vocabulary are not always accurate, with limited critical thinking ability.
20-23: Knowledge of some topics from the course syllabus, independent analytical skills only on purely practical and procedural issues, use of correct but not entirely precise and clear vocabulary, and an occasionally uncertain expository ability.
24-27: Knowledge of a broad range of topics covered in the course syllabus, ability to conduct argumentation and critical analysis independently, ability to apply knowledge to different contexts and connect topics to real cases, use of correct vocabulary and proficiency in disciplinary language.
28-30/30L: Comprehensive and thorough knowledge of the exam topics, independent ability to discuss and critically analyze themes, capacity for reflection and self-reflection, as well as for connecting topics to real cases and various contexts, excellent critical and independent thinking skills, full command of disciplinary vocabulary, and a structured, rigorous expository ability, with strong argumentative, reflective, and interdisciplinary connections skills.

Office hours

upon request, generally 8:30-18:00

Sustainable Development Goals

QUALITY EDUCATION