



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Chemistry

1920-1-E0201Q005

Aims

Knowledge and understanding. The course aims to provide students with the cognitive bases to understand the structure of organic molecules, their interactions and their reactivity.

Ability to apply knowledge and understanding. At the end of the course, students will be able to apply the acquired knowledge to problems of practical interest, applied to different fields, from basic research to industrial processes.

Autonomy of judgment. Students must be able to work out what they have learned and be able to recognize the "real" case studies and the specific problems in which the learned principles can be used.

Communication skills. At the end of the course the student will be able to appropriately communicate the topics addressed with proper language and specific terminology.

Learning skills. At the end of the course, students will be able to analyze, apply and integrate the knowledge acquired with the content of subsequent courses, with particular reference to scientific disciplines based on aspects and processes governed by chemical-molecular phenomena.

Contents

The course will introduce basics of organic chemistry:

- Organic compounds, their graphical representation and the IUPAC nomenclature
- Isomerism: constitutional isomers, conformational isomers, stereoisomers
- Acid-base reactivity in organic compounds
- Reactivity of compound classes: alkenes and alkynes, haloalkanes, alcohols, carbonyl compounds, carboxylic acids and their derivatives, amines
- Polyfunctional compounds of biological relevance
- Examples of reactivity in biological systems

Detailed program

General aspects of Organic Chemistry. Atoms involved in Organic molecules and their electrons. Hybridation of carbon atoms. Molecular orbitals, and hybrid orbitals. Representation of a structure of organic compound. Molecular orbital delocalization, properties of aromatic compounds. Polarised bonds and dipolar interactions. Intermolecular bonds. Fundamentals of chemical reactivity. Symbols and definitions. Thermodynamic and kinetic of a reaction. Reaction coordinates, activation energy, transition state, reaction intermediates. Reaction mechanisms, electrophiles, nucleophiles, radicals. Alkanes and cycloalkanes. Definition, structure, isomeric forms, nomenclature. Conformations of alkanes and cycloalkanes. Reactivity of alkanes, oxidation, halogenation. Radical reactions. Stereoisomery. Bases of stereoisomery. Stereogenic center. Enantiomers. Diastereoisomers. R and S configurations. Mesoforms. Stereogenic axis. Stereoisomers cis and trans, E e Z. Alkenes. Structure, nomenclature, physical properties. Addition of electrophiles. Carbocations, order of stability, addition of nucleophiles, transposition, elimination. Radical additions. Concerted additions, epoxidation, catalytic hydrogenation. Alkynes. Structure, nomenclature, physical properties. Acidity of terminal alkynes. Electrophile addition. Hydration and tautomery. Hydrogenation. Alkyl halides. Structure, nomenclature, physical properties. Nucleophilic substitution and elimination reactions. Mono and bimolecular mechanisms. Alcohols and thiols. Structure, nomenclature, physical properties. Acidity. Nucleophilic substitution and elimination reactions. Esters and ethers formation. Oxidation. Thiols and thioethers. Phenols. Ethers. Structure, nomenclature, physical properties and reactivity. Epoxides. Structure, nomenclature, physical properties and reactivity. Amines. Structure, nomenclature, physical properties. Basicity and nucleophilic character. Synthesis of amines. Hofmann elimination. Diazonium salts. Aldehydes and Ketones. Structure, nomenclature, physical properties. Nucleophilic addition reactions with strong nucleophiles or acid catalysed. Addition of carbon nucleophiles: cyanide, organometallic compounds. Acid catalysed addition of water, alcohols, thiols, ammonia, amines and ammonia derivatives. Tautomery. Aldol reaction. Reductions. Oxidation of aldehydes. Carboxylic acids and derivatives. Structure, nomenclature, physical properties. Acidity. Influence of the structure on the pKa. Reactivity of carboxylic acids, acyl chlorides, anhydrides, esters, amines, nitriles. Differences in their reactivity, including reduction and reaction with organometallic reagents. α -halogenation. Claisen condensation. Acetacetic and malonic synthesis. Conjugate systems. Reactivity of conjugated dienes and α,β -unsaturated carbonyl compounds. Polyfunctional compounds. Intramolecular reactions, concepts of protection and activation. Biomolecules. Carbohydrates: structure of monosaccharides, D e L, cyclic forms, α and β anomers, glycosidic bond, disaccharides, polysaccharides. Amino acids: structure, behaviour at different pH. Peptidic bond. Peptide synthesis. Nucleic acids: structure and bases complementarity. Lipids: fatty acids, triglycerides, glyco e phospholipids, terpens, steroids

Prerequisites

Background: Fundamental theory of general chemistry: atomic structure, orbitals, kinetics and thermodynamics principles.

Prerequisites: General and inorganic chemistry

Teaching form

Classroom lessons (48 h, 6 ECTS), exercise classes (20 h, 2 ECTS).

Supplementary tutorials (20 h): support for exam preparation.

Teaching language: italian.

Textbook and teaching resource

Learning material is available at the e-learning platform of the course.

Recommended textbooks:

- any organic chemistry textbook (student choice),
- any exercise textbook on organic chemistry

Semester

Second semester

Assessment method

Written + oral examination. A two-hour written examination with 10-12 questions. Students who pass the written examination are admitted to the oral one within the same session. The list of students admitted to the oral, the calendar and location will be communicated via email. The oral examination usually starts the day after the written examination, the marks of the oral and written examinations both concur to the final grade.

First year students and attending students of the subsequent years may take two mid-term written examinations. Students with sufficient grades in the two mid-term examinations may take the oral examination by February (included). Mid-term examinations do not concur to the final mark.

Office hours

Contact hours: Thursday, 12.30
