UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Chemistry

2627-1-E0202Q005

Aims

The course of Organic Chemistry will give the students the basis of organic chemistry, with a particular focus on biotechnological processes .

1. Knowledge and understanding

The student will gain knowledge of the chemical principles at the basis of organic chemistry useful for the comprehension of biological and biotechnological processes.

2. Applying knowledge and understanding

The student will be able to apply the knowledge acquired under 1. to the subsequent subjects.

3. Making judgements

The student will be able to process the acquired knowledge in organic chemistry towards its application to biotechnological processes. The following skills will be learned through exercises on the topics covered in the lectures.

4. Communication skills

Use of an appropriate scientific/chemical vocabulary and ability in oral reports

5. Learning skills

Skills in reading and understanding the subsequent studies needing a solid organic chemistry basis, skills in the application of organic chemistry knowledge to other subjects requiring organic chemistry prerequisites.

Contents

1. Organic compounds, their graphical representation and the IUPAC nomenclature

2. Isomerism: constitutional isomers, conformational isomers, stereoisomers

3. Acid-base reactivity in organic compounds

4. The reactivity of organic molecules with attention to the underlying mechanistic aspects: alkenes and alkynes, haloalkanes, alcohols, carbonyl compounds, carboxylic acids and their derivatives, amines

5. Concept of Aromaticity

6. Polyfunctional compounds of biological and biotechnological relevance

7. Examples of reactivity of organic compounds in biological systems and in some biotechnological processes

Detailed program

1. Organic compounds, their graphical representation and the IUPAC nomenclature

Elements in organic compounds, intermolecular forces and polarity; resonance theory

2. Isomerism: constitutional isomers, conformational isomers, stereoisomers

Isomer classification: structural isomers, conformers and Newman projections, stereoisomers and Fischer projections. Absolute configuration and stereochemical descriptors.

3. Acid-base reactivity in organic compounds

Acid-base equilibria; Lewis theory. Relative acidity/basicity in organic compounds: the relevance of inductive and resonance effects

4. The reactivity of organic molecules with attention to the mechanistic aspects

-alkenes and alkynes: electrophile addition (hydration, hydrohalide acids addition, halogen addition, epoxydation, ozonolysis)

- Aromatic compounds: structural characteristics and definition of aromaticity

- haloalkanes: nucleophilc substitution (SN1 and SN2), beta elimination (E1 and E2, and E1cb)

- alcohols: dehydration reactions, ether formation, transformation into alkyl halides, oxidations.

- aromatic compounds: the basis for aromaticity

- aldehydes and ketones: irreversible nucleophilic addition reactions (reductions, reactions with carbon nucleophiles); reversible (water, alcohols, primary and secondary amines); keto-enol tautomerism and the reactivity of the alpha carbon: simple, crossed and intramolecular aldol addition and condensation.

- Carboxylic acids and their derivatives: nucleophilic acyl substitution, reductions, reactions with carbon nucleophiles, hydrolysis, Fischer esterification, transesterification, saponification, synthesis of amides; reactivity of

the alpha carbon: Claisen condensation.

- Example of a biotechnological process: transesterification as the basis for the production of biodiesel.

- dicarbonyl compounds: malonic synthesis, acetoacetic synthesis.

-Amines: summary of reactions addressed with the classes of organic compounds described above (amines as nucleophiles in nucleophilic substitution reactions, in the formation of imines and enamines, in reactions with carboxylic acids and their derivatives)

5. Polyfunctional compounds of biological and biotechnological relevance

carbohydrates: structure and properties, classification, concepts of epimer and anomer, the glycosidic bond.

amino acids and proteins: structure and properties, the peptide bond and its characteristics.

nitrogenous bases, nucleosides and nucleotides: structure and properties

Triglycerides and fatty acids

6. Examples of reactivity in biological systems

SN2 mediated by S-adenosylmethionine (SAM); NADH/NAD+ and redox reactions.

imine formation in vertebrate vision mechanism

fatty acids and terpene biosynthesis.

Prerequisites

Prerequisites: General Chemistry

Background: concept of chemical equilibrium, kinetics and thermodynamics in chemical reactions, Keq, pKa and pKb definitions; hybrid orbitals

Teaching form

24 2 hours-lectures composed by:
• a section of delivered didactics (Didattica erogativa, DE, 42 hours) focused on the presentation-illustration of contents by the lecturer.
• a section of interactive teaching (Didattica Interattiva, DI, 6 hours) including teaching interventions supplementary to delivered didactic activities, short interventions by trainees, demonstrations, c, practical applications
Didactic activities are conveyed by means of face-to-face lectures
Teaching language: italian.

20 hours of Tutorial activities of interactive teaching (Didattica Interattiva, DI) on the reasoned resolution of problems aimed at guiding and assisting students throughout their studies in view of the exam preparation delivered by interactive teaching (Didattica Interattiva, DI) through 16 in-person tutorials and 4 distant learning.

The course is flanked by tutoring activities (30 h) dedicated to small groups of student during the entire semester.

The course is taught in Italian.

Textbook and teaching resource

Textbooks

Any organic chemistry textbook is suitable. A few are listed below:

- H. Hart.: Fondamenti di Chimica Organica (Zanichelli)

-Brown-Poon: Introduzione alla chimica organica 5° Ed (Edises)

-Bruno Botta: Chimica Organica 2° Ed (EDI-Ermes)

-D. Klein Fondamenti di chimica organica (Pearson)

-Gorzynski Smith Fondamenti di Chimica Organica (Mc Graw Hill)

-Wade Fondamenti di Chimica Organica (PICCIN)

Exercise book

-Eserciziario di chimica organica, F. Nicotra, L. Cipolla (EDISES)

Slides:

All slides can be found at the Moodle webpage related to the teaching module.

Recordings of the lessons will also be made available.for a short period of time

Semester

Second semester

Assessment method

Written test only, with optional oral (on request of the student or the teacher)

Written examination: knowledge of the basics of organic chemistry and ability to practice problems with organic chemical structure and reaction mechanisms. The students should demonstrate the comprehension of structure and organic chemistry reactivity, also in the biological and biotechnological field, the use of a suitable scientific language and the ability to critically re-elaborate acquired knowledge.

Oral examination: same criteria illustrated for the written examination.

Interim partial written tests are scheduled. Passing the first partial exam allows students to access the second partial exam, which will be held concurrently with the first exam session in June and may include an optional oral exam.The grade of the second partial exam, along with that of the optional oral exam, contributes to the final grade. Please note that, as per student regulations, the instructor or student may request an additional oral exam.

Office hours

Appointment requested by mail to barbara.laferla@unimib.it or cristina.airoldi@unimib.it

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