UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Chemistry (blended)

2627-2-E3202Q003-E3202Q00301

Aims

Knowledge and Understanding
At the end of the course, students will be able to:

- describe the structure of the main classes of organic compounds and the relationships between structure, properties, and reactivity;
- understand the fundamental principles governing the reactions of organic compounds;
- interpret the reactivity of organic compounds by considering stereochemical aspects and the three-dimensional arrangement of molecules;
- identify the main reaction mechanisms and the factors affecting their course.

Applying Knowledge and Understanding
At the end of the course, students will be able to:

- apply the principles of organic chemistry to the analysis and solution of problems relevant to Environmental Science and Technology;
- predict the behavior and reactivity of organic compounds based on their molecular structure;
- interpret chemical processes of environmental interest using the acquired knowledge;
- solve problems involving reaction mechanisms, stereochemistry, and transformations of organic compounds.

Making Judgements
At the end of the course, students will be able to:

- critically analyze chemical problems and identify the information required for their solution;
- evaluate alternative reaction pathways and select the most appropriate solutions based on organic chemistry principles;
- formulate hypotheses and draw reasoned conclusions regarding the behavior of organic compounds in applied and environmental contexts.

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Communication Skills
At the end of the course, students will be able to:

- use the scientific language and terminology of organic chemistry correctly and appropriately;
- represent and describe molecular structures, stereochemistry, and reaction mechanisms using suitable formulas, schemes, and models;
- communicate concepts, procedures, and results related to organic chemistry clearly and rigorously.

Learning Skills
At the end of the course, students will be able to:

- integrate previous knowledge of general chemistry and other basic scientific disciplines with the concepts of organic chemistry;
- independently deepen their understanding of specialized topics through the consultation of textbooks and scientific sources;
- develop an interdisciplinary approach to the interpretation of chemical and environmental phenomena;
- update and expand their knowledge to address advanced courses and applied problems in the field of Environmental Science and Technology.

Contents

Natural organic compounds and synthetic organic compounds. Electronic structure and chemical bonding. Organic structures: functional groups. Systematic nomenclature of organic compounds. Organic reactions: reactions of alkanes and cycloalkanes. Stereoisomerism. Chirality. Chemical reactions and stereoisomerism. Alkenes. Alkynes. Haloalkanes: nucleophilic substitution and elimination reactions. Alcohols and ethers. Amines and other nitrogen-containing derivatives. Carbonyl compounds: aldehydes and ketones. Carboxylic acids and their derivatives. Benzene and other aromatic compounds.

Detailed program

Introduction
Natural organic compounds and synthetic organic compounds.

Chemical Bonding and Isomerism
The structure of the carbon atom in organic compounds. Organic compounds and their graphical representation. Three-dimensional molecular structure. Chirality. Enantiomerism and diastereoisomerism.

Alkanes and Cycloalkanes
Positional, configurational, and conformational isomerism. Chemical nomenclature. Oxidation, combustion, and halogenation. Radical chain reactions. Petroleum.

Alkenes, Alkynes, and Dienes
The carbon–carbon double bond. Electrophilic addition. Carbocations. Polymerization. Oxidation and reduction reactions.

Halogen Derivatives (Haloalkanes)
Nucleophilic substitution reactions (SN1 and SN2) and elimination reactions (E1 and E2).

Alcohols
Nucleophilic substitution, elimination, and oxidation reactions. Ethers and epoxides: nucleophilic attack.

Amines
Basicity of amines. Nucleophilic substitution and elimination reactions.

Carbonyl Compounds: Aldehydes and Ketones
Reactions under acidic and basic conditions. Nucleophilic addition. Keto–enol tautomerism. Carbanions. Aldol condensation. Reduction and oxidation reactions.

Carbonyl Compounds: Carboxylic Acids and Their Derivatives
Acidity of carboxylic acids. Reactions under acidic and basic conditions. Nucleophilic acyl substitution (addition–elimination mechanism). Claisen condensation.

Benzene and Other Aromatic Compounds
Resonance stabilization. Hückel's rule. Electrophilic aromatic substitution. Inductive and mesomeric effects in electrophilic aromatic substitution. Nucleophilic aromatic substitution.

Prerequisites

General and inorganic chemistry

Teaching form

- 20 lessons (2 h), 40 h Delivered Didactics in presence
- 3 exercises (2 h) 6 h total Interactive Teaching in presence
- 2 exercises (2 h) 4 h total Interactive Teaching on line

Textbook and teaching resource

Harold Hart. Fondamenti di Chimica Organica. CHIMICA ZANICHELLI 2025

Semester

First semester

Assessment method

The final examination consists of a single oral exam at the end of the course, graded on a scale from 18 to 30/30 with honors (cum laude). The exam includes the discussion of various topics covered during the course. The

questions are designed to assess students' understanding of the fundamental principles of organic chemistry through the study of the properties and reactivity of functional groups. Knowledge of nomenclature and stereochemical principles will also be evaluated.

The final grade will range from 18/30 to 30/30 with honors, based on the overall assessment and considering the following criteria described in the objectives of the course:
• conceptual knowledge and understanding
• ability to apply knowledge and understanding
• communication and argumentation skills
• learning, self-assessment, and self-regulation skills

Grade < 18
Knowledge and understanding:
The student only partially identifies the structure of main organic compounds and the relationships between structure, properties, and reactivity. Understanding of the fundamental principles governing organic reactions is fragmented and poorly supported by theoretical knowledge. The ability to interpret reactivity in stereochemical and three-dimensional terms is very limited.
Applying knowledge and understanding:
The student is not able to apply the principles of organic chemistry to solve simple problems or to predict molecular reactivity based on structure. Knowledge is not used to interpret processes of environmental relevance.
Making judgments:
The student is unable to critically analyze chemical problems or identify relevant information. They cannot evaluate alternative reaction pathways or formulate reasoned conclusions.
Communication skills:
Scientific language is used inadequately. The representation of structures and mechanisms is incomplete or incorrect. The oral exposition is disorganized and lacks coherence.
Learning skills:
The student shows difficulty in integrating prior knowledge and does not demonstrate the ability to independently deepen or structure their learning process.

Grade 18–22
Knowledge and understanding:
The student recognizes and describes the basic structure of main organic compounds and the fundamental relationships between structure, properties, and reactivity. Understanding of reaction principles is correct but superficial. Stereochemical and three-dimensional interpretation is present but not always accurate.
Applying knowledge and understanding:
The student partially applies the principles of organic chemistry, managing to solve only simple problems. Prediction of reactivity and interpretation of environmental processes show gaps.
Making judgments:
The student identifies some relevant elements but struggles to analyze them critically. Evaluation of alternative reaction pathways is elementary and not always consistent.
Communication skills:
Scientific language is used in a simple but not always accurate way. Representation of structures and mechanisms is basic. Oral exposition lacks structure.
Learning skills:
The student demonstrates a basic awareness of their learning path and is able to establish some connections between topics, although not in a systematic way.

Grade 23–27
Knowledge and understanding:
The student demonstrates a good understanding of the structure of organic compounds and the relationships between structure, properties, and reactivity. Reaction principles are well understood. Stereochemical and three-dimensional interpretation is generally correct.
Applying knowledge and understanding:
The student correctly applies the principles of organic chemistry to problem solving and to the prediction of

molecular reactivity. They are able to interpret environmentally relevant processes with good operational autonomy.
Making judgments:
The student analyzes chemical problems appropriately, identifying relevant information and generally evaluating different reaction pathways correctly.
Communication skills:
Scientific language is appropriate and used with good accuracy. Representation of structures and mechanisms is correct. Oral exposition is clear and well organized.
Learning skills:
The student shows good ability to integrate prior knowledge and to independently deepen topics, demonstrating a structured learning process.

Grade 28–30 with honors
Knowledge and understanding:
The student demonstrates comprehensive and in-depth knowledge of the structure of organic compounds and the relationships between structure, properties, and reactivity. Reaction principles are fully mastered, with advanced interpretation also in stereochemical and three-dimensional terms.
Applying knowledge and understanding:
The student independently and rigorously applies organic chemistry principles to solve complex problems and to predict molecular reactivity. They are able to interpret and model environmentally relevant chemical processes with high accuracy.
Making judgments:
The student critically analyzes complex problems, identifies all relevant information, and evaluates alternative reaction pathways with full awareness, formulating well-reasoned and coherent conclusions.
Communication skills:
The student demonstrates full command of scientific language and specialized terminology. Representation of structures, stereochemistry, and mechanisms is accurate and rigorous. Oral exposition is fluent, structured, and logically coherent.
Learning skills:
The student demonstrates a high level of self-directed learning, interdisciplinary integration, and independent study, developing a mature and well-structured learning pathway.

Office hours

Always, after scheduling an appointment via e-mail.

Sustainable Development Goals

QUALITY EDUCATION | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION