UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Organic Chemistry of Materials With Laboratory

2526-2-ESM01Q008

Aims

The aim of course is to provide the student with the essential practical skills for a safe and corrected approach to experimental organic chemistry. The course also provides the student with the suitable knowledge about the basic techniques for purification and characterization of organic compounds. Aspects on the chemical behaviour and reactivity of alcohols, amines, tiols, ethers, tioether, carbonylic derivatives (ketones and aldehydes) and carboxylic acids and their derivatives will be also provided.

Knowledge and understanding
At the end of the course, the student knows:

- The main classes of organic substances (see list in the detailed content)
- The main properties and reactions of the organic substances listed in the detailed content
- The main purification methods of organic compounds (separation, extraction, crystallization, distillation and chromatography)
- Characterization methods for organic molecules (melting point and chromatographic methods);
- Principal synthetic approach to organic compounds (condensation, reduction, alkylation, esterification and diazonium salt reactions);
- Knowledge about the chemical behavior and reactivity of alcohols, amines, tiols, ethers, tioether, carbonylic derivatives (ketones and aldehydes) and carboxylic acids and their derivatives.

Applying knowledge and understanding
At the end of the course, the student is able to:

- Have the basic knowledge on the organic substances listed in the detailed content
- Apply the main reactions of the organic substances listed in the detailed content
- Perform an easy synthesis of an organic compound starting from commercially available materials;
- Purify and characterize the synthesized organic materials.

Making judgements

At the end of the course, the student is able to:

- Recognize the main structural and chemical properties of the organic substances listed in the detailed content
- Apply the main reactions on the organic substances listed in the detailed content
- choose the most appropriate synthetic approach, purification and characterization methods to prepare and analyse an organic compound.

Communication skills
Knowing how to describe in a clear and concise way in writing and orally with the language properties the main concepts of organic chemistry and the properties and reactivity of the main organic substances.
To be able to describe laboratory procedures and results in a technical report in a clear and concise way.

Learning skills
To be able to apply the acquired knowledge to contexts different from those presented during the course.

Contents

The course constitutes in two parts:

The first part deal with the chemical behavior and reactivity of alcohols, amines, tiols, ethers, tioether, carbonylic derivatives (ketones and aldehydes) and carboxylic acids and their derivatives.

LABORATORY ACTIVITIES
Safety and behavior aspects for conducting correctly an organic chemistry experiment. Basic technical operations in organic chemistry (crystallization, distillation, selective solvent extraction and chromatographic techniques). Single and/or multi step organic reactions involving functional group transformations (aldol condensation, carbonyl reduction, diazocopulation reaction).

Detailed program

The course constitutes in two parts.

The first part deal with the chemical behavior and reactivity of alcohols, amines, tiols, ethers, tioether, carbonylic derivatives (ketones and aldehydes) and carboxylic acids and their derivatives. In particular, the physical properties, nomenclature rules, reactivity towards specific reagents and specific experimental conditions will be illustrated. The discussion of electrophilic aromatic substitution reactions will be completed by analyzing the effect of substituents. Nucleophilic substitution reactions on compounds other than alkyl halides. Nucleophilic acyl substitution reactions and nucleophilic addition reactions. Addition and condensation reactions on carbonyl compounds will also be discussed.

LABORATORY ACTIVITIES
Safety and behavior aspects for conducting correctly an organic chemistry experiment. Basic technical operations in organic chemistry (crystallization, distillation, selective solvent extraction and chromatographic techniques). Single and/or multi step organic reactions involving functional group transformations (aldol condensation, carbonyl reduction, alkylation, esterification, diazocopulation reaction).

In particular, the experiments conducted in laboratory are:

- Identification of organic compounds by Thin Layer Chromatography (TLC).
- Separation of a mixture of benzoic acid and dibenzylamine by selective solvent extraction. Benzoic acid purification by crystallization and dibenzylamine purification by reduced-pressure distillation.
- Separation of two organic dyes by column chromatography
- Aldol condensation
- Reduction of a ketone with sodium borohydride
- Friedel-Crafts alkylation
- Alcohol dehydration
- Fisher esterification
- Preparation and coupling reaction of diazonium salt.

Prerequisites

Chimica Generale ed Inorganica dei Materiali (first year)
Chimica Organica per i Materiali (first year)

Teaching form

FOR CLASSROOM ACTIVITIES
Lectures and practical classes held in italian

- 7 two-hour lectures, in person, Delivered Didactics
- 12 two-hour practical classes, in person, Interactive Teaching

FOR LABORATORY ACTIVITIES
Lectures and laboratory held in italian

- 1 two-hour lecture, in person, Delivered Didactics;
- 1 two-hour and 11 four-hour lab activities (46 hours overall), in person, Interactive Teaching.

Textbook and teaching resource

FOR CLASSROOM ACTIVITIES
P. Y. Bruice, Elementi di Chimica Organica, Edises
A. Abbotto, N. Manfredi, O. Bettucci, "Chimica organica", Scienza Express, 2025

FOR LABORATORY ACTIVITIES

- Course notes
- A. Vogel, Vogel's Textbook of Practical Organic Chemistry, 5th ed., Longman Scientific & Technical

Semester

Second year, first semester

Assessment method

The assessment method employed to check the level of understanding of the concepts taught during the course constitutes of two parts.

The first part is a written exam where the student have to answer to questions on the aspects concerning the chemical characteristics and reactivity of alcohols, amines, tiols, ethers, tioether, carbonylic derivatives (ketones and aldehydes) and carboxylic acids and their derivatives.

ASSESSMENT OF CLASSROOM ACTIVITIES

- Written test in the form of exercises and open questions on the topics covered in class
- Oral test as a discussion interview on the written test

ASSESSMENT OF LABORATORY ACTIVITIES

- Assessment of behaviour during laboratory activities, specifically regarding the respect of safety rules
- Closed-ended tests performed "in itinere" to evaluate the understanding of the day-to-day activity
- Report on laboratory activities, to evaluate the student communication skills and autonomous judgment of their work

The written test is passed and gives access to the oral test with a grade equal to or greater than 15/30. The oral test is an improvement on the written test and optional for students who have a grade of the written test equal to or greater than 18/30.

The final grade of the frontal part (written and oral) must in any case be equal to or greater than 18/30 to pass the exam.

At the end of the test, the student will be given a grade out of thirtieths which is the weighted average between the grade obtained in the frontal part and the grade obtained in the laboratory part. The exam is passed with a minimum final grade of 18/30 obtained by passing the written test and the positive evaluation of the laboratory part. Upon specific request, the exam can be taken in English.

Intervals of evaluation:

18-19: the student is prepared on a small number of program topics, their dissertation and analysis abilities are limited and only emerge after questioning and help from the examiner; their ability to expose and lexicon used is not always correct, and they lack critical thinking;
20-23: the student is prepared on a fair number of program topics, their dissertation and analysis abilities are limited; they use a correct but inaccurate lexicon, and they are hesitant during exposition;
24-27: the student is prepared on a good number of program topics, they are autonomous during discussion and show critical thinking abilities; they are capable to apply knowledge to real cases, and make use of correct lexicon;
28 – 30/30L: the student preparation on program topics is complete and exhaustive, their are capable of fully autonomous dissertation and critical thinking, they display full fluency and well-structured lexicon.

The exam is passed with a minimum final grade of 18/30 following the passing of the written test and the positive evaluation of the laboratory part.

Office hours

Prof. Manfredi meets students from 14:30 to 16:30 by appointment
Dr. Mattiello meets students from 9:30 to 12:30 by appointment

Sustainable Development Goals

QUALITY EDUCATION | RESPONSIBLE CONSUMPTION AND PRODUCTION