# **.- Organic Chemistry**

## Prof. Gian Maria Beone

### ***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

**Knowledge and ability to understand**: The course aims to provide students with the basic knowledge of Organic Chemistry aimed at understanding the steric and electronic properties and effects that govern the reactivity of different functional groups, highlighting, from time to time, any links with the biological world.

**Understanding and application of knowledge**: Alongside the frontal lectures, classroom tutorials will be conducted in order to carry out exercises that facilitate the understanding of the subject. This activity will enable students to apply their knowledge, so reinforcing and accelerating its acquisition.

**Making judgments**: Students should ideally acquire complete autonomy in their ability to foresee the products obtained from the treatment of different classes of organic compounds with the main oxidising and reducing agents, electrophiles and nucleophiles, acids and bases.

**Communication skills**: Students must be able to communicate using the typical terminology of organic chemistry in an appropriate manner. The use of educational material in electronic format will facilitate and stimulate the use of information technology in managing communication. Especially in the guided tutorials, the teaching methodology involves dealing with the proposed problems collectively, stimulating group discussion and an ability to reach the result through a process of summarising the contributions that emerge in the discussion.

**Learning** **skills**: Development of a logical thought process that will facilitate the skills needed to further study the biochemical processes and transformations underlying food technologies, with a high level of autonomy.

### ***COURSE CONTENT***

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|  | ECTS |
| **Introduction** | 0.5 |
| Lewis structures, electronegativity and formal charge. Electronic structure of Carbon and hybridisation. Molecular orbitals σ and π. Resonance structures. Brønsted-Lowry acids and bases and Lewis acids and bases. Electrophiles and nucleophiles. |  |
| **Aliphatic and aromatic hydrocarbons** | 2.0 |
| Alkanes and cycloalkanes. The IUPAC nomenclature system. Nomenclature and physical properties of alkanes and cycloalkanes. Conformational analysis of alkanes and cycloalkanes. Cis-trans isomerism in cycloalkanes. Methane halogenation: mechanism of radical substitution. Thermodynamic and kinetic aspects of chemical reactions. Reaction profile: transition state and activation energy.  Alkenes, alkynes and dienes. Nomenclature and properties of alkenes. Cis-trans isomerism. E-Z nomenclature. Heat of hydrogenation and stability of alkenes. Mechanism and examples of electrophilic addition to the double bond. Nomenclature of alkynes. Acidity of alkynes. Electrophilic addition to the triple bond. Structure of the dienes and stability of conjugated dienes. Isoprene and Terpenes.  Aromatic compounds. Benzene: aromaticity and resonance energy. Brief notes on polycyclic aromatic hydrocarbons. Aromatic electrophilic substitution mechanism. |  |
| **Compounds containing a σ C-Z bond (where Z is a more electronegative element)** | 2.0 |
| Stereochemistry. Molecular chirality and enantiomers. The R, S system. Optical activity. Diastereoisomers and meso compounds.  Properties of halogenoalkanes. Nucleophilic Substitution and Elimination reactions.  Alcohols, phenols, ethers and thiols. Nomenclature and acid-base properties of alcohols. Alcohol reactivity linked to breakage of R-OH and RO-H bonds. Reactivity and acidity of alcohols versus phenols. Nomenclature and properties of ethers and thiols.  Amines. Nomenclature, classification and basicity of aliphatic and aromatic amines. Brief notes on the reactivity of aliphatic amines. |  |
| **Compounds containing a C=O group** | 1.0 |
| Aldehydes and ketones. Structure and nomenclature. Mechanism and examples of nucleophilic addition to the carbonyl. Oxidation of aldehydes.  Carboxylic acids and functional derivatives. Structure and nomenclature. Substituent effects on the acidity of carboxylic acids. Nucleophilic acyl substitution mechanism and relative reactivities of carboxylic acid derivatives.  Reactivity of alpha hydrogens of carbonyl compounds: enolisation of aldehydes, ketones and esters. Aldol and Claisen condensation. |  |
| **Compounds of biological interest** | 0.5 |
| Di-, and tricarboxylic acids, hydroxy and keto acids. Aromatic heterocyclic compounds. Fats and oils. Structure and stereochemistry of monosaccharides: D-Aldoses and D-Ketoses. |  |
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| Tutorials | 1.0 |

### ***READING LIST***

J.G. Smith, *Fondamenti di Chimica Organica*, 4a ed., McGraw-Hill, 2023.

W.H. Brown-T. Poon, *Introduzione alla Chimica Organica*, 7a ed., EdiSES, 2023.

L.G. WADE, JR., *Fondamenti di Chimica Organica*, 8a ed., Piccin, 2014.

P.C. Vollhardt, N.E. Schore, *Chimica Organica*, 4a ed., Zanichelli, 2016.

Slides of the lectures and additional teaching material on the online course page (<https://blackboard.unicatt.it>).

### ***TEACHING METHOD***

The course is organised over 48 hours of lectures and 12 hours of tutorials for a total of 7 ECTS.

The lectures use PowerPoint, audio and video presentations, made available to students on the Blackboard platform on a weekly basis (<https://blackboard.unicatt.it>). The theoretical discussion is always accompanied by applied examples and opportunities for student involvement, asking questions on the subjects being covered so as to stimulate reflection and a self-assessment of their knowledge.

The frontal tutorials are aimed at illustrating examples and at carrying out exercises aimed at consolidating the acquired knowledge.

The course includes an additional 12 hours of support dedicated to exercises proposed by students.

For individual work, exercises and closed-ended tests on the topics in progress are made available on Blackboard on the Connect platform (McGraw-Hill Education).

The preferred book is provided in Smartbook form through online registration on the Connect website; this offers students a personalised reading experience and guidance in their assimilation of the contents in a way that is suited to their learning rhythm.

### ***ASSESSMENT METHOD AND CRITERIA***

An optional on-going test is provided, consisting of closed-ended and video-terminal questions, aimed at verifying the student's preparation on the structure and reactivity of certain classes of organic compounds. Passing the interim test with a mark no lower than 18/30, exempts a student from preparing the corresponding parts of the course program for the final exam.

The final oral exam will assess the student's ability to relate the reactivity with the molecular properties (structure) of organic compounds and the transformation of functional groups, with the appropriate use of specific terminology. The oral exam will be marked out of thirty and will be averaged with the mark obtained in the interim test.

The exam must be completed in its entirety (verbalised with a single mark) before the end of the autumn session. After this deadline the interim test mark will no longer be valid.

Student who do not intend to take advantage of the pass mark obtained for their interim test and the relative partial exemption, may take the oral exam on the entire course program. The ongoing assessment is not an obstacle to taking the exam in traditional oral form.

### ***NOTES AND PREREQUISITES***

Attendance at tutorials is strongly recommended.

Only students regularly enrolled in the teaching of Organic Chemistry on the Blackboard platform may take the ongoing test.

To take the oral exam, students must have passed the General and Inorganic Chemistry (Agricultural Sciences and Technology degree) exam or the General Chemistry and Physical Chemistry (Food Sciences and Technology degree) exam.

### ***OFFICE HOURS***

Prof. Gian Maria Beone receives students after class hours and by appointment every day at the Agricultural, Food and Environmental Chemistry area of the Department of Food Science and Technology for a Sustainable agro-food supply chain - Di.S.T.A.S.