# UNIVERSITÀ DEGLI STUDI DI PALERMO

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| **DEPARTMENT** | Scienze e Tecnologie Biologiche, Chimiche e Farmaceutiche |
| **ACADEMIC YEAR** | 2017/2018 |
| **BACHELOR'S DEGREE (BSC)** | BIOLOGICAL SCIENCES |
| **SUBJECT** | ORGANIC CHEMISTRY WITH PRACTICE |
| **TYPE OF EDUCATIONAL ACTIVITY** | A |
| **AMBIT** | 50024-Discipline chimiche |
| **CODE** | 15959 |
| **SCIENTIFIC SECTOR(S)** | CHIM/06 |
| **HEAD PROFESSOR(S)** | GRUTTADAURIA MICHELANGELO — Professore Ordinario — Univ. di PALERMO<br>LO MEO PAOLO MARIA GIUSEPPE — Professore Associato — Univ. di PALERMO |
| **OTHER PROFESSOR(S)** | |
| **CREDITS** | 9 |
| **INDIVIDUAL STUDY (Hrs)** | 149 |
| **COURSE ACTIVITY (Hrs)** | 76 |
| **PROPAEDEUTICAL SUBJECTS** | |
| **MUTUALIZATION** | |
| **YEAR** | 1 |
| **TERM (SEMESTER)** | 2° semester |
| **ATTENDANCE** | Not mandatory |
| **EVALUATION** | Out of 30 |
| **TEACHER OFFICE HOURS** | **GRUTTADAURIA MICHELANGELO**<br>Monday 12:00 13:00 Studio, Viale delle Scienze, Ed. 17<br>Wednesday 12:00 13:00 Studio, Viale delle Scienze, Ed. 17<br>**LO MEO PAOLO MARIA GIUSEPPE**<br>Monday 15:00 17:00 Studio del docente, V.le delle Scienze Ed. 17. |

**DOCENTE:** Prof. MICHELANGELO GRUTTADAURIA- *Lettere A-K*

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| **PREREQUISITES** | General chemistry concepts (electronegativity, atomic orbitals, hybridization, acids and bases) |
| **LEARNING OUTCOMES** | Knowledge of the tools for the recognition of functional groups, of the various classes of compounds and the processing associated with them.<br>Comprehension of the reactivity of the functional groups and autonomous development of a reaction transformation.<br>Ability to use the specific language of their own discipline and ability to understand reaction mechanisms and their application in biochemical models. |
| **ASSESSMENT METHODS** | The written examination will seek to determine the possession of skills, capacity and provided expertise.<br>Written test consists of 8-10 exercises and open questions (during the course will be carried out and discussed many examples of tasks).<br>It will be provided an ongoing evaluation in mid-course. The teacher will suggest the topics to be covered in the test in progress. Those who pass the test will play a final task based on the topics covered in the second part of the course program.<br>The final grade will take into account the ongoing evaluation of the test and the final examination..<br>In case the student does not pass the test in progress, the final examination will cover the whole program.<br>It is possible to reject the vote of the ongoing evaluation.<br>The final examination aims at assessing whether the student has knowledge and understanding of the subject matter, has acquired interpretative competence and autonomy in judging concrete cases. The threshold of sufficiency (18/30) will be reached when the student shows knowledge and understanding of the topics at least in the general guidelines and has minimum application competencies in at least 6/10 of the task. Below this threshold, the examination is insufficient. The more knowledge and skills of the examiner go into the details of the discipline being tested, the more the evaluation will be positive. The correct and complete resolution of all exercises is evaluated as 30/30. |
| **EDUCATIONAL OBJECTIVES** | The course of Organic Chemistry for the degree in Biological Sciences will be characterized by a descriptive-phenomenological approach. The different classes of compounds, the different classes of reactions,the reactivity of functional groups as well as the structural and stereochemical aspects are presented as a basis for the study of biochemical processes. |
| **TEACHING METHODS** | - Lectures.<br>- Exercises. |
| **SUGGESTED BIBLIOGRAPHY** | - W. H. Brown, T. Poon, “Introduzione alla Chimica Organica” (V ed.) EdiSES 2014<br>- P. Yurkanis Bruice, “Elementi di Chimica Organica” (II ed), EdiSES, 2017 |

## SYLLABUS

| Hrs | Frontal teaching |
|---|---|
| 5 | Basics of Inorganic Chemistry: atomic and molecular structure, atomic orbitals, chemical bond and molecular orbitals, hybridization and resonance: Intermolecular forces. General theory of acids and bases. Kinetics and thermodynamics of chemical reactions. Collisions theory, concept of reaction mechanism. Functional Groups |
| 5 | Alkanes: Nomenclature, structural and conformational isomerism. Combustion enthalpies. Cycloalkanes |
| 4 | Stereochemistry: enantiomerism and diastereoisomerism, chiral molecules and absolute configuration, optical activity, Racemes, molecules with more than one chiral center. Chirality in biochemistry |
| 5 | Alkenes and alkynes: geometric isomerism, E/Z nomenclature, Electrophilic addition, oxidation and reduction reactions. Polymerization. Acidity of alkynes |
| 5 | Alkyl halides: Nucleophilic subtitution and elimination reactions, energy vs. reaction coordinate diagrams |
| 5 | Alcohols: physical properties, amphoterism and nucleophilic reactivity, inorganic esters, dehydration, oxidation. Diols and polyols. Ethers and epoxides. Thiols: acidity and reactivity |
| 2 | Aliphatic amines: basicity and nucleophilic reactivity |
| 2 | Conjugate systems: Allylic system. Dienes: structure and reactivity |
| 6 | Aldehydes and ketones: Nucleophilic addition reactions, hemiacetals, acetals, cyanohydrins, imines, enamines. Oxidation and reduction, acidity of hydrogen atoms in alpha-position, keto-enol tautomerism |
| 6 | Carboxylic acids and their derivatives: acidity and factors affecting it, Fischer esterification, Nucleophilic acylic substitution, Acyl chlorides, anhydrides, thioesters, esters, amides, esterification and hydrolysis, oxyacids, ketoacids, bicarboxylic acids |
| 3 | Enolate reactions: aldol condensation, Claisen condensation |
| 2 | Lipids: generalities, saturated and insaturated fat acids, triglycerides and phospholipids. Structure of steroids |
| 4 | Carbohydrates. Monosaccharides: steric series, cyclic structures, reduction, oxidation, glycosides, mutarotation. Disaccharides: maltose, cellobiose, lactose, sucrose. Polysaccharides: amylose, amylopectine, cellulose, glycogen. Aminosugars and desoxysugars |

# SYLLABUS

| Hrs | Frontal teaching |
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| 4 | Aminoacids: structure and configuration; acid-base equilibria and isoelectric point, peptide bond, synthesis and analysis of peptides. Primary structure of peptides and its determination. Secondary, tertiary and quaternary structure of proteins and factors stabilizing them |
| 6 | Aromatics and Heteroaromatics: Benzene and its derivatives, Electrophilic aromatic substitution, electronic substituent effects. Phenols and quinones; aromatic amines. Heterocyclic compounds: pyrrole, imidazole, pyridine, pyrimidine. Tautomerism in heterocyclic compounds. Purine and pyrimidine bases, structure of nucleosides and nucleotides |

| Hrs | Practice |
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| 12 | Exercises: Guided resolution of exwercises on the topics discussed during the front lectures, training for the final exam, paying particular attention to nomenclature, stereochemistry, molecular properties, reactivity of functional groups, structure-reactivity relationship. |

**DOCENTE:** Prof. PAOLO MARIA GIUSEPPE LO MEO- *Lettere L-Z*

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| **PREREQUISITES** | General chemistry concepts (electronegativity, atomic orbitals, hybridization, acids and bases) |
| **LEARNING OUTCOMES** | Knowledge of the tools for the recognition of functional groups, of the various classes of compounds and the processing associated with them.<br>Comprehension of the reactivity of the functional groups and autonomous development of a reaction transformation.<br>Ability to use the specific language of their own discipline and ability to understand reaction mechanisms and their application in biochemical models. |
| **ASSESSMENT METHODS** | The written exam will seek to determine the possession of the skills, abilities and expertise provided. The exam consists of 8-10 tests including both exercises and open questions (during the course many examples will be carried out and discussed). A mid-course evaluation test is provided. The teacher will indicate the topics to be covered in the mid-course test. The student has the possibility of refusing the score attributed to the mid-course test, by communicating it within the end of the course. Those who pass the mid-course test will take a final test based on the topics covered in the second part of the course. In case the student does not pass the mid-term test or rejects its score, he/she will take an exam on the entire program. The final grade will take into account the mid-term test and the final exam, depending on the weight attributed by the teacher to the two parts of the program covered.<br>The mid-term test and the final exam will evaluate whether the student has acquired knowledge and understanding of the course topics, interpretation skills and autonomy of judgment in real situations. The base level (18/30) is reached if the students shows at least a fair knowledge and understanding level and application skills in at least 6/10 of the tests. Below this level, the score will be considered not sufficient. The more knowledge and application skills will be shown deep and detailed, the more positive the final grade of the exam will be. The complete and correct resolution of all the tests will get full scores (30/30), possibly cum laude. |
| **EDUCATIONAL OBJECTIVES** | The course of Organic Chemistry for the degree in Biological Sciences will be characterized by a descriptive-phenomenological approach. The different classes of compounds, the different classes of reactions,the reactivity of functional groups as well as the structural and stereochemical aspects are presented as a basis for the study of biochemical processes. |
| **TEACHING METHODS** | Lectures, Exercises |
| **SUGGESTED BIBLIOGRAPHY** | - W. H. Brown, C. S. Foote, B. L. Iverson, Anslyn “Chimica Organica”, (V ed.), EdiSES, 2014<br>- P. Yurkanis Bruice, “Elementi di Chimica Organica” (II ed), EdiSES, 2017 |

## SYLLABUS

| Hrs | Frontal teaching |
|---|---|
| 5 | Basics of Inorganic Chemistry: atomic and molecular structure, atomic orbitals, chemical bond and molecular orbitals, hybridization and resonance: Intermolecular forces. General theory of acids and bases. Kinetics and thermodynamics of chemical reactions. Collisions theory, concept of reaction mechanism. Functional Groups. |
| 5 | Alkanes: Nomenclature, structural and conformational isomerism. Combustion enthalpies. Cycloalkanes. |
| 4 | Stereochemistry: enantiomerism and diastereoisomerism, chiral molecules and absolute configuration, optical activity, Racemes, molecules with more than one chiral center. Chirality in biochemistry. |
| 5 | Alkenes and alkynes: geometric isomerism, E/Z nomenclature, Electrophilic addition, oxidation and reduction reactions. Polymerization. Acidity of alkynes. |
| 5 | Alkyl halides: Nucleophilic subtitution and elimination reactions, energy vs. reaction coordinate diagrams. |
| 5 | Alcohols: physical properties, amphoterism and nucleophilic reactivity, inorganic esters, dehydration, oxidation. Diols and polyols. Ethers and epoxides. Thiols: acidity and reactivity. |
| 2 | Aliphatic amines: basicity and nucleophilic reactivity. |
| 2 | Conjugate systems: Allylic system. Dienes: structure and reactivity. |
| 6 | Aldehydes and ketones: Nucleophilic addition reactions, hemiacetals, acetals, cyanohydrins, imines, enamines. Oxidation and reduction, acidity of hydrogen atoms in alpha-position, keto-enol tautomerism. |
| 6 | Carboxylic acids and their derivatives: acidity and factors affecting it, Fischer esterification, Nucleophilic acylic ubstitution, Acyl chlorides, anhydrides, thioesters, esters, amides, esterification and hydrolysis, oxyacids, ketoacids, bicarboxylic acids. |
| 3 | Enolate reactions: aldol condensation, Claisen condensation. |
| 2 | Lipids: generalities, saturated and insaturated fat acids, triglycerides and phospholipids. Structure of steroids. |
| 4 | Carbohydrates. Monosaccharides: steric series, cyclic structures, reduction, oxidation, glycosides, mutarotation. Disaccharides: maltose, cellobiose, lactose, sucrose. Polysaccharides: amylose, amylopectine, cellulose, glycogen. Aminosugars and desoxysugars. |
| 4 | Aminoacids: structure and configuration; acid-base equilibria and isoelectric point, peptide bond, synthesis and analysis of peptides. Primary structure of peptides and its determination. Secondary, tertiary and quaternary structure of proteins and factors stabilizing them. |

# SYLLABUS

| Hrs | Frontal teaching |
|---|---|
| 6 | Aromatics and Heteroaromatics: Benzene and its derivatives, Electrophilic aromatic substitution, electronic substituent effects. Phenols and quinones; aromatic amines. Heterocyclic compounds: pyrrole, imidazole, pyridine, pyrimidine. Tautomerism in heterocyclic compounds. Purine and pyrimidine bases, structure of nucleosides and nucleotides. |

| Hrs | Practice |
|---|---|
| 12 | Exercises: Guided resolution of exwercises on the topics discussed during the front lectures, training for the final exam, paying particular attention to nomenclature, stereochemistry, molecular properties, reactivity of functional groups, structure-reactivity relationship. |