



# Dipartimento di Scienze e Tecnologie

ACADEMIC YEAR 2017/2018

DEGREE in Biotechnology  
COURSE of Organic Chemistry

TEACHER: Prof. Giuseppe Graziano

**Covalent bonds and carbon compounds.** Atomic and molecular orbitals. Hybrid orbitals:  $sp^3$ ,  $sp^2$  and  $sp$ . Application to methane, ethene and ethine molecules. Resonance and delocalization: benzene. Geometric structure of molecules.

**Alkanes and cycloalkanes.** The structure of alkenes and their physical properties. Concept of structural isomerism. IUPAC nomenclature. Structure of cycloalkanes. Conformational analysis.

**Stereochemistry.** Definition of chiral molecules. Asymmetric carbon as a stereo center. Enantiomers. Nomenclature of stereoisomers: the R and S system. Fischer projections. Acyclic molecules with two or more stereo-centers. Optical activity. Separation of enantiomers.

**Alkenes.** Structure, physical properties and nomenclature of alkenes. Chemical reactivity of alkenes. Reactions of electrophilic addition to the carbon-carbon double bond. Regiochemistry and stereochemistry. Reorganization of carbocations. Hydroboration. Oxidation and reduction of alkenes. Polymerization. Conjugated dienes.

**Alkynes.** Structure and nomenclature. Acidity of terminal alkynes. Reactivity.

**Alkyl halides.** Structure, physical properties and nomenclature. Reactions of nucleophilic substitution. Mechanisms  $SN_1$  and  $SN_2$ . Reactions of beta-elimination and their mechanisms. Competition between substitution and elimination. Organometallic compounds: Grignard reagents. Halogenation of alkanes: radical chain mechanism.

**Alcohols, ethers and epoxides.** Structure, physical properties and nomenclature. Importance of hydrogen bonds. Reaction with alkaline metals. Dehydration. Synthesis of alcohols for reduction of carbonyl compounds. Williamson's synthesis of ethers.

**Aldehydes and ketones.** Structure, physical properties and nomenclature. Nucleophilic addition of water, alcohols, hydrogen cyanide and Grignard reagents. Oxidation and reduction. Wittig's reaction. Condensation reactions with ammonia derivatives.

**Carboxylic acids and their derivatives.** Structure, physical properties, nomenclature and acidity of carboxylic acids. Dicarboxylic acids, esters, anhydrides, acyl chlorides and amides. Reactions of acyl nucleophilic substitution.

**Acidity of hydrogens in alpha to carbonyl groups.** Keto-enol tautomerism. Aldol condensation. Claisen condensation. Malonic synthesis and acetoacetic synthesis.



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**Aromatic compounds.** The structure of benzene and the concept of aromaticity according to Huckel. Reactions of aromatic electrophilic substitution: halogenation, nitration, sulphonation, alkylation and acylation. Effects of activation/deactivation and orientation of the substituents in the reactions of aromatic electrophilic substitution.

**Synthetic polymers.** Polymerization reactions: Poly-additions and poly-condensation. Average molecular weight of a polymer. Polyethylene, polystyrene, styrene-butadiene copolymers. Isotactic polypropylene. Polyesters and polyamides. Biodegradable polymers.

**Lipids.** Triglycerides, soaps and detergents. Micelles. Steroids. Phospholipids and double layer.

**Amino acids and proteins.** Structure and acid-base properties of alpha amino acids. Isoelectric point. Peptide bond. Primary, secondary, tertiary and quaternary structure of globular proteins. Determination of the sequence of amino acids in a protein.

**Carbohydrates.** Cyclic structure of monosaccharides. D and L nomenclature. Mutarotation. Disaccharides: maltose, cellobiose and sucrose. Polysaccharides: starch and cellulose.

Textbooks:

Organic Chemistry - Brown, Foote and Anslyn - EdiSES