

Course guide

320064 - QOBA - Organic Chemistry and Applied Biochemistry

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Morillo Cazorla, Margarita
Garriga Sole, Pere

Others: Morillo Cazorla, Margarita
Garriga Sole, Pere
Ramon Portés, Eva

PRIOR SKILLS

In order to successfully meet the objectives of this subject, students will be expected to have passed Chemistry (first semester).

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

1. CHE: Knowledge of material and energy balances, biotechnology, the transfer of materials, separation operations, chemical reaction engineering, the design of reactors, and the reuse and transformation of raw materials and energy resources.

Transversal:

2. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
4. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.

TEACHING METHODOLOGY

Methodology includes four types of sessions:

1) Face-to-face lecture

Lecturer will introduce the theoretical fundamentals of the subject, concepts, methods and results, which will be illustrated with relevant examples to facilitate their understanding.

2) Applied sessions.

Lecturer-led problem-solving and Problem-solving in small groups (2-3 students) or individually.

3) Distance independent-learning sessions.

4) Distance teamwork sessions.

Students are expected to spend time outside of class working in teams to solve one of the problems related to organic synthesis processes assigned by the lecturer. Using appropriate bibliographical sources, each student will have to search for instructions on how to correctly carry out the practical, draft a protocol for solving the problem, and present the protocol.

Each team will have tutoring/consulting time with the lecturer prior to the presentation of the solution to the problem.

LEARNING OBJECTIVES OF THE SUBJECT

Students will learn to do the following:

- Recognise the various families of organic compounds by functional group.
- Associate the main organic reactions with functional group reactions.
- Understand the reaction mechanisms in which functional groups are involved.
- Understand and apply the stereoisomerism and conformational analysis of organic compounds.
- Understand of the procedures used in organic synthesis.
- Know the main natural products of industrial interest.
- Know the chemical and biochemical bases of biotechnology.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

TOPIC 1: INTRODUCTION TO INDUSTRIAL ORGANIC CHEMISTRY

Description:

- Functional group.
- Concept and types of isomerism.
- Concept and types of reaction intermediate.
- Reaction mechanisms.
- Classification of organic reactions.

Specific objectives:

On completing this topic, students will have acquired the ability to:

- Differentiate between empirical formula, molecular formula, structural formula and semi-structural formula.
- Correctly calculate empirical and molecular formulas.
- Differentiate between the various types of isomers.
- Apply the appropriate nomenclature rules to geometric and chiral stereoisomers.
- Differentiate between homolytic fission and heterolytic fission.
- Differentiate between different types of reaction intermediates.
- Differentiate between different reaction mechanisms.

Full-or-part-time: 14h

Theory classes: 2h

Practical classes: 1h

Self study : 11h

TOPIC 2: CHEMICAL BEHAVIOUR OF HYDROCARBONS

Description:

- Free-radical reactions with alkanes, alkenes and alkynes.
- Carbocation reactions with alkenes and alkynes.
- Differences between 1,2 addition and 1,4 addition in conjugated dienes.
- SEAr reactions in aromatic compounds (benzene and derivatives).

Specific objectives:

On completing this topic, students will be able to:

- Understand the differences between free-radical reactions and carbocation reactions.
- Understand the difference in complexity of the final products according to the reaction mechanism.
- Understand the concept of electron mobility as the foundation for resonance structures.
- Apply the concept of electron resonance to explain electrophilic aromatic substitution reactions.
- Perform conformational analysis of alkanes and, by extension, open-chain compounds.
- Understand the difference between staggered and eclipsed conformations, especially in cyclohexane and its derivatives.

Full-or-part-time: 20h

Theory classes: 6h

Practical classes: 2h

Self study : 12h

TOPIC 3: CHEMICAL BEHAVIOUR OF COMPOUNDS WITH AN OXIDATION STATE OF 1, 2 OR 3

Description:

- Reactions with alcohols and ethers. Influence of the type of alcohol (primary, secondary or tertiary) on the reaction mechanism.
- Concerted and stepwise reactions.
- Substitution and elimination reactions.
- Carbonyl group reactions in compounds with oxidation state of 2 (aldehydes and ketones). Concept of nucleophilic addition.
- Carbonyl group reactions in compounds with oxidation state of 3 (acids and derivatives). Concept of acyl group substitution.
- Comparison of nucleophilic addition and acyl group substitution.
- Aldol condensation as a specific case of nucleophilic addition. Carbanion reactions.

Specific objectives:

On completing this topic, students will be able to:

- Differentiate between the chemical behaviour of primary, secondary and tertiary alcohols.
- Predict, on the basis of the nucleophile used, the type of reaction that an alcohol will undergo (nucleophilic substitution or elimination).
- Differentiate between the behaviour of strong and weak nucleophiles in nucleophilic addition.
- Explain acyl group substitution and differentiate between it and carbonyl group nucleophilic addition.
- Understand the behaviour of carbanions.
- Explain aldol condensation.

Full-or-part-time: 32h

Theory classes: 8h

Practical classes: 3h

Self study : 21h

TOPIC 4: ORGANIC SYNTHESIS

Description:

- Methods for obtaining the main aliphatic compounds.
- Methods for obtaining benzene derivatives. Influence of activating/deactivating groups on the benzene ring.
- Interaction between various methods for obtaining organic compounds. Introduction to organic synthesis.

Specific objectives:

On completing this topic, students will be able to:

- Understand the main methods for obtaining organic products.
- Set up a multi-step organic synthesis.
- Optimise synthesis (i.e. use the smallest possible number of steps while obtaining maximum efficiency).

Full-or-part-time: 26h

Theory classes: 3h

Practical classes: 3h

Self study : 20h

TOPIC 5. INDUSTRIAL ORGANIC PRODUCTS

Description:

- Agrochemical products: pesticides, insecticides, herbicides and fungicides. Environmental problems.
- Surfactants: structure and types. Biodegradability of detergents. Environmental problems.
- Organic dyes and pigments: azo dyes. Other dyes. Environmental problems.
- Polymers: classification and types.
- Free-radical, cationic and anionic polymerisation.

Specific objectives:

On completing this topic, students will be able to:

- Differentiate between the various types of products developed to combat pests.
- Understand the recent change in mindset in terms of respect for the environment.
- Differentiate between soaps and synthetic detergents.
- Understand the historical changes that have taken place in this field with the introduction of respect for the environment.
- Understand the importance of azo dyes as an example of specific organic synthesis.
- Understand the historical changes that have taken place in this field with the introduction of respect for the environment.
- Understand polymerisation reactions as a complement to the reaction mechanisms covered in topics 2 and 3.
- Understand the importance of these types of reactions in modern industrial organic chemistry.

Full-or-part-time: 20h

Theory classes: 9h

Practical classes: 3h

Self study : 8h

TOPIC 6: BIOMOLECULES

Description:

- Carbohydrates. Cyclisation of monosaccharides. Mutarotation. Formation of derivatives. Glycosidic bonds. Disaccharides and polysaccharides. Homopolysaccharide and heteropolysaccharides.
- Lipids. Structure and properties of saponifiable lipids. Structure and properties of non-saponifiable lipids.
- Amino acids. Acid-base properties. Isoelectric point. Peptide bond. Proteins. Primary, secondary, tertiary and quaternary structure of proteins. Denaturation of proteins. Enzymes: definition, properties and classification. Apoenzymes and holoenzymes. Definition of cofactor, coenzyme, cosubstrate and prosthetic group. Michaelis-Menten kinetics. Lineweaver-Burk transformation. Activation and inhibition of enzyme activity. Dependence on pH and temperature. Denaturation of enzymes.
- Nucleic acids: nucleosides and nucleotides. DNA: Stabilising forces. RNA, main types: mRNA, tRNA and rRNA. Characteristics and functions.

Specific objectives:

On completing this topic, students will be able to:

- Understand how carbohydrates are classified by Fischer projection.
- Recognise cyclic structure as a specific case of nucleophilic addition to the C=O double bond.
- Recognise the difference between oils and fats.
- Understand the importance of C=C double bonds in the fatty acid chain.
- Understand the wide range of substances classified as lipids and their relationship to more complex natural products.
- Understand how amino acids are classified by Fischer projection.
- Understand their amphoteric behaviour.
- Understand the structure and properties of oligo- and polypeptides.
- Understand the forces that stabilise protein structures.
- Understand that enzymes are special proteins that act as catalysts.
- Understand that enzymes are much more powerful than synthetic catalysts.
- Understand that enzymes are activated in aqueous solutions under very mild temperature and pH conditions.
- Understand that cells contain two varieties of nucleic acid: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA).
- Understand that DNA forms part of genes, the hereditary material of cells, and contains instructions for producing the proteins that the organism needs.
- Understand that RNA is associated with the transmission of genetic information from the nucleus to the cytoplasm, where protein synthesis occurs.
- Understand that there are three types of RNA: messenger (mRNA), transfer (tRNA) and ribosomal (rRNA).

Full-or-part-time: 22h

Theory classes: 10h

Practical classes: 2h

Self study : 10h

TOPIC 7: CHEMICAL AND BIOCHEMICAL FOUNDATIONS OF BIOTECHNOLOGY

Description:

- Concept and brief historical overview of biotechnology.
- Characteristics of industrial biotechnological processes: obtaining the best biological catalyst for a specific process or function; obtaining the best environment for the function of this biological catalyst by means of a series of technical designs; processing material (separation and purification of the biological material produced).
- Industrial applications: ethanol production; acetone-butanol fermentation; production of antibiotics; animal cell culturing; production of biopolymers.

Specific objectives:

On completing this topic, students will be able to:

- Understand that biotechnology can be defined, broadly, as the application of biological organisms or systems to the production of goods or services.
- Understand that modern biotechnology is a highly interdisciplinary field with many areas of application.
- Identify the variety of raw materials that go into industrial biotechnological processes.
- Understand the use of microorganisms, cells and enzymes to obtain industrial products.

Full-or-part-time: 16h

Theory classes: 7h

Practical classes: 1h

Self study : 8h

GRADING SYSTEM

The final qualification (NF) shall be calculated as follows:

$$NF = 0.30 \cdot NE1 + 0.20 \cdot NE2 + 0.25 \cdot NE3 + 0.10 \cdot NT + 0.15 \cdot NQ$$

NE1: first exam qualification

NE2: second exam qualification

NE3: third exam qualification

NT: work qualification

NQ: exercise and questionnaire qualifications

Students with a qualification of less than 5 in the first and second exams can return to unsatisfactory results with a written exam of the subject that will take place on the same day as the third exam and during the schedule stipulated for this exam. Qualification obtained in this exam will replace the initial one as long as it is higher.

For those students who meet the requirements and take the re-evaluation exam, the grade of the re-evaluation exam will replace the grades of all the evaluation acts that are written tests in person (controls, partial and final exams) and the qualifications of problems, questionnaires, papers, projects and presentations obtained during the course will be maintained. If the final qualification after reevaluation is less than 5.0 it will replace the initial one only in the case that it is higher. If the final qualification after the re-evaluation is greater than or equal to 5.0, the final qualification of the subject will be approved 5.0.

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