VNIVERSITAT DE VALÈNCIA

Course Guide
33164 Biomolecular chemistry

COURSE DATA

Data Subject	
Code	33164
Name	Biomolecular chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1102 - Degree in Biotechnology	Faculty of Biological Sciences	1	Second term

Subject-matter

Degree	Subject-matter	Character
1102 - Degree in Biotechnology	79 - Chemistry	Basic Training

Coordination

Name	Department
ZABALLOS GARCIA, ELENA	325 - Organic Chemistry

SUMMARY

The Chemistry of Biomolecules is a subject of basic training of four-month nature that is taught in the second term of the first year of the degree in Biotechnology. In the curriculum there are a total of 6 ECTS credits. With this subject is intended that the student deepen in those knowledge of Organic Biological Chemistry acquired in previous courses. This knowledge and skills will establish the essential basis so that the student can subsequently address the study of the different aspects of biochemistry in which biomolecules chemistry are involved. As the subject is integrated in the degree of Biotechnology, it must be specifically oriented towards biological processes.

The subject has a mixed theoretical-experimental character.

The basic lines contained in the program of the subject are articulated around the fundamental concepts in organic chemistry. In particular it is intended that the student becomes familiar with the concepts of structure, bonding, functional groups, properties and basic reactivity of organic molecules of particular biological relevance.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

In order to successfully address the subject, it is essential that the student possesses a series of prior knowledge, according to the required level courses in high school. Such knowledge includes:

Nomenclature and chemical formula, both inorganic and organic.
Set of chemical reactions.
Basic stoichiometric calculations.
Know how to apply the concept of hybridization to explain the geometry of simple molecules.
Know the different types of intermolecular forces
Identification of common base -aci

OUTCOMES

1102 - Degree in Biotechnology

- Saber trabajar de forma adecuada en laboratorio incluyendo seguridad, manipulación y eliminación de residuos y registro anotado de actividades.
- Saber expresarse correctamente en términos matemáticos, estadísticos, químicos, físicos y biológicos.
- Emplear correctamente y con soltura la calculadora científica y otras herramientas de cálculo.
- Saber formular correctamente cualquier compuesto inorgánico u orgánico de relevancia biológica e identificar sus grupos funcionales y su comportamiento en soluciones acuosas.
- Ser capaz de predecir las propiedades químicas y la reactividad de compuestos inorgánicos y orgánicos relevantes en biología en base a la estructura atómica y/o molecular.
- Saber manejar correctamente unidades de concentración y preparar disoluciones ajustadas en volumen, concentración y a pH determinado.

LEARNING OUTCOMES

MINIMUM CONTENTS

To overcome the subject, there are a series of minimum objectives of conceptual nature that is essential to reach:

- Knowing the structure and bonding in organic molecules.
- IUPAC nomenclature of simple organic molecules.
- Understanding the concept of orbital hybridization and its application to organic molecules.
- Lay the basis for understanding the representation of three-dimensional molecules.
- Identify and justify the acidity-basicity of various types of organic substances in nature.
- Understanding the redox concept in organic molecules and their biological significance.
- Define the term isomerism and lay the foundations to distinguish the different types of isomerism that may occur, with more emphasis on stereoisomerism.
- Make a study of intermolecular forces, devoting more attention to the hydrogen bonds, establishing its importance in the physical properties of biomolecules.
- Establish the concepts, electrophilic and nucleophilic. Distinguish the main types of reactions in organic chemistry preferably using a mechanistic approach.
- Structure and properties of molecules of biological importance.

SKILLS TO ACQUIRE

- Namely organic nomenclature to ask any simple organic molecule correctly.
- Namely making Lewis structures and identify hybridization of the atoms in a biomolecule.
- Acquire basic notions of stereochemistry to distinguish compounds which differ only in their three-dimensional structure.
- Assign the R or S configuration at stereogenic carbons.
- Predicting the acid-base behavior of organic molecules.
- Understand the concepts nucleophile-electrophile and their application to the reactivity in Organic Chemistry.
- Get acquainted with the concepts: inductive effect and resonance effect
- Distinguish different types of organic reactions from the mechanistic point of view.
- Link the knowledge acquired during the course with the reactions that occur in metabolism.
- Recognize the different types of biomolecules.

SOCIAL SKILLS

- Ability to work together when dealing with problematic situations collectively.
- Ability to argue from rational criteria.
- Ability to build a comprehensive and organized written text.
- Ability to obtain adequate information with which to confront new scientific problems that arise.

DESCRIPTION OF CONTENTS

1. CLASSIFICATION AND NOMENCLATURE OF ORGANIC COMPOUNDS

Representation of organic molecules. Main types of organic compounds; functional group, classification of functional groups. Empirical and molecular formula. Index of hydrogen deficiency. Naming organic compounds.

2. BONDING IN ORGANIC MOLECULES

Bonds in the molecule of methane, ethane, ethylene and acetylene. Hybridization of atomic orbitals and bond length. Hybrid orbital in the oxygen and nitrogen. bonds in formaldehyde and methylimine. Electronegativity and bond polarity. Inductive effect. Resonant structures. Conjugation and aromaticity.

3. ISOMERISM

Classification of isomers. Structural isomers. Stereoisomers. Geometrical isomerism. Nomenclature system E / Z. Representation of three-dimensional structures. Optical isomerism. Enantiomers. Optical activity. Specific rotation. Racemic mixture. Configuration. Nomenclature system R / S. Diastereoisomers. Meso compound. Stereoisomerism in cyclic compounds. Resolution of racemates. Conformational isomers. Conformational analysis of simple alkanes. Conformations of cyclic compounds.

4. ACIDS AND BASES

Acidity. pKa tables. Electronic and structural effects affecting acidity of organic compounds. Basicity. Influence of steric and electronic effects on the basicity. Basicity of some nitrogen heterocycles. Polyfunctional acids. Acid-base interactions. Amphoteric compounds. Amino acids.

5. ORGANIC REACTIONS

Mechanism of reaction. Classification of organic reactions. Nucleophiles and electrophiles. Mechanism and kinetics of a reaction. Intermediates and transition states. Oxidation levels of organic compounds

6. NUCLEOPHILIC REACTIONS

Nucleophilic substitution, SN1 and SN2. Nucleophilic eliminations, E1 and E2. Competition between substitution and elimination

7. NUCLEOFILIC REACTIONS POF CARBONYL GROUP

Structure of the carbonyl group. Nucleophilic additions to aldehydes and ketones. Addition of water, alcohol, hydride, carbon nucleophiles, addition of ammonia and derivatives to aldehydes and ketones. Nucleophilic substitution in carboxylic acids and derivatives. Fischer esterification. Transesterification. Esters hydrolysis. Lactones. Amides. Hydrolysis of amides. Lactams. Nucleophilic substitution in phosphoric acids.

8. CARBOHYDRATES

Classification of carbohydrates. Monosaccharides. Classification of monosaccharides. Configuration D / L. Mutarotation. Glycosides. Enolization, tautomerism and isomerization. Ether formation. Ester formation. Formation of cyclic acetals. Oxidation and reduction of monosaccharides. Disaccharides. Polysaccharides. Polysaccharide hydrolysis.

9. AMINO ACIDS, PEPTIDES AND PROTEINS

Properties of -amino acids. Acid-base properties of -amino acids. Common reactions of -amino acids. Protection of the carboxyl group. Protection of the amino group. Resolution of amino acids. Peptides and proteins. Structure of a peptide. Determination of the structure of a peptide. Analysis of the N-terminal and C-terminal amino acid.

10. LIPIDS AND NUCLEIC ACIDS

Classification of lipids. Fatty acids, Fats and Oils. Waxes. Lipids of biological interest. Components of nucleic acids. Purine and pyrimidine bases.

11. LABORATORY PRACTICALS

1. Stereochemistry of organic compounds. Molecular models.
2. Intermolecular forces and physical properties of organic compounds.
3. Acid-base extraction. Isolation and purification of a solid compound.
4. Acid-base extraction. Isolation and purification of a liquid compound.
5. Extraction and separation of a natural product.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	41,00	100
Laboratory practices	15,00	100
Tutorials	4,00	100
Preparation of evaluation activities	30,00	0
Preparing lectures	34,00	0
Preparation of practical classes and problem	26,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course of the subject is structured around four axes: Traditional lectures, Problem classes, Small group tutorial and the development of Laboratory classes

Traditional lectures: students will attend three sessions per week. These sessions will offer an overview of the topic and will emphasize in the key concepts for understanding of it. The student will be provided with a written document containing the information for each topic in advance.

Problem classes: for these classes the students will be provided, in advance and through the Virtual Classroom, with a collection of problems that will allow them to apply the contents learnt in the theory classes.

Small group tutorial: the tutorials consist of four compulsory class attendances, it will take place in groups of no more than sixteen students. In these classes the teacher will solve individual questions or collective proposals made by the students. Tutoring session will end with the resolution, by the student, of a short question-test of about 25 minutes.

Laboratory classes: of compulsory attendance, will take place in groups of no more than sixteen students who have the constant supervision of a teacher. In the first session, the student will be provided with all the information needed to perform safely and efficiently the experimental work. Moreover, during this same session, how to elaborate a Laboratory record will be explained. At the beginning of each session, if requested and prior to any experimental work, students will submit the preparatory problems associated to the particular session resolved. Next, the professor will discuss the characteristics of the experiment, highlighting the basic concepts included therein.

EVALUATION

Assessment of student' learning will take into account three different aspects:

1. Continuous evaluation and student's progress work developed throughout the course, mainly the test resolution during the tutorial sessions (10%)

2. Written exam at the end of the course (75%): this exam will be held on the date indicated by the Faculty. In order to pass the subject is required to obtain a minimum of 50 points out of 100.

3. Evaluation of laboratory work (15%): preparation of experimental work, resolution of the proposed issues, safety rules, experimental handling and results will be considered. Part of the evaluation will

consist of brief test (30 minutes) concerning the work carried out in the laboratory.

It is important to note that for the first call a minimum score of 40 out of 100 points in the previous part **3** is required.

The minimum grade to pass the subject is 50 out of 100 points.

For the second call, only the part corresponding to the theoretical and laboratory exam, or both, will be evaluated again.

NOTE: The student may renounce the continuous evaluation. In order to do so, he must submit a written resignation to the Organic Department just after the first tutoring and on the date indicated by the teacher. In this case 85% of the final grade will be associated to the written exam.

REFERENCES

Basic

- Referencia b1: Paula Yurkanis Bruice, Fundamentos de Química Orgánica. 3ª edición, Pearson Education, 2015.

Referencia b2: Karen C. Timberlake, Química General. Orgánica y Biológica Prentice Hall, 2011.

Referencia b3: P.M. Dewick, Essentials of Organic Chemistry. Ed. Wiley, 2006.

Referencia b4: F.A. Bettelheim and J. March, Introduction to Organic and Biochemistry. Ed. Saunders College Publishing. United States of America, 1990.

Referencia b5: H. Hart, L.C. Craine, D.J. Hart, C.M. Hadad. Química Orgánica. McGraw-Hill, 2007.

Referencia b6: "ChemBioOffice Ultra", PerkinElmer (CambridgeSoft). Amplia selección de aplicaciones y funcionalidades que permite estudiar, dibujar, formular, modelar y editar estructuras moleculares químicas y biológicas.

Additional

- K.P.C. Vollhart y N.E. Schore, Química Orgánica, 3ª Ed Omega, 2000 (3ª Edicion).
- L.J. Wade, Química Orgànica. Ed. Prentice Hall, Pearson Education, 2004 (5ª Edición).
- Streitweiser y C.H. Heathcock, Química Orgánica. Ed. Interamericana 1986 (3ª Edición).
- J. Sales y J. Vilarrasa, Introducció a la nomenclatura química. (4ª Edición). EDUNSA, Barcelona (1994).
- https://www.uv.es/quimicajmol/index.htm > Colección de problemas interactivos de Química Orgánica con videos y gráficos.