COURSE DATA

Data Subject	
Code	33120
Name	Biomolecular chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Faculty of Biological Sciences	1	Second term

Subject-matter

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	1 - Química	Basic Training

Coordination

Name	Department
PEREZ PRIETO, JULIA	325 - Organic Chemistry

SUMMARY

Chemistry of biomolecules is a basic skills course that is taught in the second semester of the first year of the degree in Biochemistry and Biomedical Sciences. The curriculum consists of a total of 6 ECTS credits.

With this subject it is intended for the student to gain an in-depth knowledge of those subjects on Biological Organic Chemistry acquired in the high school courses and, in some degree, to complete them. These knowledge and skills will establish the essential foundations to address later on the study of the various aspects of the biochemistry of biomolecules. As the subject is integrated in the degree of Biochemistry and Biomedical Sciences, the approach to the study of chemical properties and chemical phenomena should be directed specifically toward biological processes.

The subject has a theoretical-experimental character, so that to the theoretical concepts are added practical ones with the analysis and resolution of questions and the realization of practical experiments in the laboratory to apply the concepts studied in the classroom as well as to familiarize the student with the physical and human environment in the laboratory work.

The basic outlines contained in the program of this course are articulated around key concepts in organic chemistry. In particular, it is intended for the student to be proficient with the concepts of structure, link, functional groups, basic properties and 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 be able to deal successfully with the subject, it is essential for the student to possess a prior knowledge, according to the level required in the courses of secondary school and in the Chemistry course of the first semester.
These skills include:
Nomenclature and chemical formulation, both inorganic and organic.
To understand the structure and bonds in molecules.
To formulate Lewis structures.
To understand the concept of orbital hybridization and its application to molecules

OUTCOMES

1101 - Degree in Biochemistry and Biomedical Sciences

- Conocer los principios químicos de la estructura del átomo y los enlaces químicos, de la estequiometría de las reacciones químicas, de la termodinámica y del equilibrio químico, de las propiedades de los equilibrios ácido-base y rédox y de la estructura y reactividad de los compuestos orgánicos.
- Saber aplicar los conceptos físicos y químicos teóricos a casos prácticos de índole biológica.
- Manejar la nomenclatura química y las reglas de formulación y estequiometría.
- Conocer la estructura del átomo de carbono, la hibridación de orbitales y su aplicación a las moléculas orgánicas, así como el carácter tridimensional de éstas.
- Conocer las propiedades químicas de las moléculas orgánicas y de sus grupos funcionales.
- Conocer los principios químicos de la estructura y propiedades de los azúcares, los aminoácidos, los lípidos y los nucleótidos.

LEARNING OUTCOMES

MINIMUM CONTENTS

A number of targets are essential to successfully pass the course:

• To understand the structure and bond in organic molecules.

• Organic Chemistry IUPAC nomenclature of simple molecules.

• To understand the concept of orbital hybridization and electron delocalization and their application to the structure and behavior of organic molecules.

• To understand the representation of three-dimensional molecules.

• To identify and justify the acid-basic properties of various types of organic substances.

• To understand the concept of oxidation-reduction in organic molecules and their biological relevance.

• Define the term isomerism and be able to distinguish between different types of isomers which may appear, with especial emphasis on stereoisomerism.

• Define the term conformation and to know the basic points to recognize and analyze the changes in the molecule by rotation of atoms around their links.

•Study of intermolecular forces, specially the hydrogen bond, and the recognition of their important role in the physical properties of biomolecules.

• Establish the concepts, electrophile and nucleophile.

• Distinguish the major types of reactions in organic chemistry preferably through a mechanistic approach.

• Structure and properties of biologically important molecules.

SKILLS TO ACQUIRE

• To be able to formulate and name simple organic molecules.

• To recognize and use the specific nomenclature systems for the most important biomolecules.

• To draw Lewis structures and be able to identify the hybridization of atoms and their spatial arrangement in a biomolecule.

• To acquire basic notions on stereochemistry to be able to recognize and distinguish between compounds that only differ in their three-dimensional structure.

• To be able to assign the correct configuration R or S to a stereogenic carbon.

• To be able to recognize the changes on the stability of a molecule if the atoms spin around single bonds.

• To predict the acid-base behavior of organic molecules

• To understand the concepts nucleophile and electrophile and its application to the reactivity in Organic Chemistry.

• To understand and correctly apply the concepts of inductive effect and resonance effect to the chemical behavior of organic compounds.

• To differentiate organic reactions from a mechanistic point of view.

• To be able to apply previous points to the reactions than occur in biological processes.

• To be able to recognize the different types of biomolecules and to predict in general terms their three-dimensional structure and their chemical behavior.

SOCIAL SKILLS

• The ability to work in a team and to face problematic situations collectively.

• The ability to argue from rational criteria and to build a written text understandable and organized.

• The ability to obtain adequate information with which to tackle new scientific problems.

DESCRIPTION OF CONTENTS

1. ORGANIC COMPOUNDS: BONDS, STRUCTURE AND NOMENCLATURE

The carbon bonds: hybridization and geometry. Resonance structures. Resonance and MO view of the bond. Organic compounds classification. Molecular formula. Isomerism. Drawing organic compounds. Functional groups: structure, geometry, physical properties and nomenclature. Intermolecular bonds.

2. STEREIOSMERISM

Definitions. Geometric isomers: alkenes and cycloalkanes. Nomenclature E/Z. Optical isomers: Chirality and optical activity. Enantiomers and racemic mixtures. Optical rotation. Elements of symmetry. Fisher projections. Absolute and relative configuration. Nomenclature R/S. Compounds with several stereogenic carbons: diastereomers, epimers and meso compounds. Resolution of racemic mixtures. Compounds with other stereogenic atoms. Some other causes of chirality.

3. CONFORMATIONAL ISOMERS

Rotation around single bonds: conformations. Conformational analysis: ethane, butane. Conformations cyclic compounds: cyclopropane, cyclobutane, cyclopentane. Cyclohexanes. Substituted cyclohexanes. Factors that may influence the stability of the conformations. Condensed systems: decalins. Cycloalkanes bridge. cycloalkenes.

4. CHEMICAL REACTIONS OF ORGANIC COMPOUNDS I

Review of basic topics. Reaction mechanisms. Intra-and intermolecular structural effects. Acidity and basicity of organic compounds. Keto-enol tautomerism. Bond cleavage and reaction intermediates. Nucleophiles and electrophiles. Main reaction intermediates: carbocations, free radicals and carbanions.

5. CHEMICAL REACTIONS OF ORGANIC COMPOUNDS II

Classification of organic reactions. Nucleophilic substitution on Csp3 and Elimination. Free-radical reactions. Electrophilic addition reactions. Nucleophilic Addition Reactions. Substitution on acyl carbons. Electrophilic aromatic substitution. Oxidation and Reduction

6. CHEMICAL REACTIONS ON BIOMOLECULES

Chemical processes in living organisms: primary and secondary metabolites. Enzymes. Activation coenzymes: ATP, CoASH. Redox coenzymes: NADH, FAD. Alkylation coenzymes: SAM. Coenzymes for carbanion stabilization: TPP, PLP.

7. CARBOHYDRATES (SUGARS)

Classification and nomenclature. MONOSACCHARIDES: Representation and configuration: Fisher projections, cyclic structures, Haworth formulas. Conformation of monosaccharides. Mutarotation. Reactions due to the carbonyl group: Isomerization, nucleophilic additions. Reactions due to OH. Oxidations. Reductions. DISACCHARIDES: Nomenclature. Saccharose. Lactose. Disaccharides of D-glucose. Sweeteners. OLIGOSACCHARIDES AND POLYSACCHARIDES: Classification. Structure-activity relationship. Starch. Glycogen. Cellulose and derivatives. Chitin. pectic substances. Glycosaminoglycans.

8. AMINO ACIDS, PEPTIDES AND PROTEINS

AMINO ACIDS: structure and nomenclature. Essential amino acids. Configuration. Physical properties. Acidity, basicity and isoelectric point. Reactions of amino acids in the laboratory. Reactions of amino acids in living beings. Amino acid resolution. PEPTIDES: Nomenclature. Classification. The peptide bond. Disulfide bridge. Acid-base behavior and reactions.

9. LIPIDS

Classification. Fatty acids: structure, properties and nomenclature. Reactions of fatty acids. Fats and oils. Waxes. Lipids of biological interest: phospholipids, glycolipids , Prostaglandins, Steroids.

10. LABORATORY EXPERIMENTS

1. INTRODUCTION TO THE LABORATORY AND STEREOCHEMISTRY. MOLECULAR MODELS.
2. PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS. INTERMOLECULAR FORCES.
3. PROPERTIES OF BIOMOLECULES.
4. EXTRACTION AND SEPARATION OF A NATURAL PRODUCT. CROMATOGRAPHY.
5. ISOLATION OF NATURAL PRODUCTS.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	41,00	100
Laboratory practices	15,00	100
Tutorials	4,00	100
Preparation of evaluation activities	35,00	0
Preparing lectures	28,00	0
Preparation of practical classes and problem	27,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the course is structured around four points: the theoretical lectures, problem classes, tutoring sessions and the practical laboratory work.

Students will attend to two theoretical lectures a week in which an overview of the key concepts of a topic will be presented. Previously to each session a document containing all the information for each topic will be available for them through the Virtual Classroom, as well as additional information on the most suitable resources for their learning.

For the preparation of the problems lessons, a list of questions will also be available to the student, to apply and study in depth the contents of the theory lectures. In these lessons (9 scheduled for the whole group) a number of problems-type will be resolved for the teacher to allow the student to identify the essential points and approach to the resolution of the problems of each topic. In these lessons the spotlight will fall primarily on the teacher, who will present the key points of the global approaches and specific issues in each case.

Tutorials sessions (4 set), which are of compulsory attendance, will begin by a test about the most basic aspects of the assigned topic, sometimes individually (10-15 min / session), and others in pairs or in groups (30 min / session). After the test an open discussion will be carried out on doubts or analysis of specific aspects of higher complexity.

Laboratory sessions, which are of mandatory attendance, will be held in groups of sixteen students under the supervision and advice of a teacher present at all times.

An introductory session will provide the student with all the information needed to perform safely and efficiently the experimental work, the appropriate method for the preparation and registration of the experimental work and as a work timetable.

Students will carry out simple chemical experiments. Prior to each session students will answer some questions related to the experiment and at the beginning of the session, the teacher will discuss the main points of the experience, highlighting the need to understand the main concepts included therein. After the development of the laboratory work the students should hand in the results of their experience and answer some questions related to the experiment they have carried out. The teachers might also ask for the students to hand in a detailed report of the experience/s.

EVALUATION

The assessment of student learning will take place in three different stages: Continuous assessment of progress and the work developed throughout the course, based primarily on the issues and problems solved by students in tutorials and tracking course. Written exam at the end of the course. Evaluation of laboratory work: preparation of experimental work, respect safety rules, handling and results. Part of the evaluation will consist of the realization of short written tests. The student answer simple basic questions about the contents of the work done, student knowledge and control over the information gathered throughout the sessions so to carry it out have the information you have gathered.

The final grade will consist of:

10% continuous assessment.

75% written exam.

15% of the work in the laboratory.

For evaluation a minimum rating of 4 out of 10 is required in the written examination and / or laboratory work to pass the course. Students who have not reached the score of 4 out of 10 in laboratory work must take a written test (1hr approx.) This will replace the test scores of the first call and make half with the rest of their lab scores. Students who have not completed a minimum experimental work should also conduct an experimental test

REFERENCES

Basic

- -Paula Yurkanis Bruice. Fundamentos de Química Orgánica. 3a edició, Pearson Educación (2015).
  -K.C. Timberlake. Organic and Biological Chemistry: Structures of Life, 4a edició. Pearson (2013).
  -ChemBioOffice Ultra, PerkinElmer (CambridgeSoft). Ampla selecció daplicacions i funcionalitats que permeten estudiar, dibuixar, formular, modelar i editar estructures moleculars químiques i biològiques.
  Otros libros pueden contener básicamente la misma información: Consultar con el profesor)

Additional

- Models moleculars. Eina per a lestudi de lestructura tridimensional de les molècules. Sen poden trobar distints models.
  http://www.sinorg.uji.es/docencia.htm