COURSE DATA

DATA SUBJECT

Code: 33120
Name: Biomolecular chemistry
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Facultat de Ciències Biològiques	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	Química	BASIC

COORDINATION

BALLESTEROS GARRIDO RAFAEL

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.

COMPETENCES / LEARNING OUTCOMES

1101 -

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 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.

Conocer los principios químicos de la estructura y propiedades de los azúcares, los aminoácidos, los lípidos y los nucleótidos.

Manejar la nomenclatura química y las reglas de formulación y estequiometría.

Saber aplicar los conceptos físicos y químicos teóricos a casos prácticos de índole biológica.

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

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	4,00
Theory	41,00
Laboratory	15,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00

Independent study and work	0,00
Preparation of lessons	55,00
Preparation for assessment activities	35,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

The course is structured around four main components: theory sessions, problem-solving sessions, tutorials, and the development of a practical laboratory project.

For the problem-solving sessions, students will be provided with a set of questions designed to help them apply and deepen their understanding of the concepts covered in the theory classes. During the problem-solving classes (9 scheduled for the whole group), a series of typical problems will be worked through to help students learn to identify the key elements involved in problem formulation and resolution for each topic.

The tutorial sessions (4 scheduled) are mandatory and will serve to clarify concepts and address both general and specific questions.

The laboratory sessions, also mandatory, will be carried out in groups of sixteen students, each supervised by a professor who will be present at all times. In an introductory session, students will receive all the necessary information to safely, effectively, and thoroughly conduct the experimental work, including the proper method for preparing and recording the experiments, along with a work schedule. Students will carry out basic chemical experiments. At the beginning of each session, the responsible instructor will explain the characteristics of the experiment and highlight the key concepts involved. The laboratory guide will be made available to students before the sessions begin.

EVALUATION

Student learning will be assessed through three components: continuous assessment of progress and work carried out throughout the course, mainly based on the questions and problems solved during tutorials and overall course engagement; a written final exam; and an evaluation of laboratory work, including preparation, adherence to safety standards, experimental handling, and the results obtained.

The final grade will consist of 10% from continuous assessment, 75% from the written exam, and 15% from laboratory work.

To pass the course, students must obtain a minimum score of 5 out of 10 in both the written exam and the laboratory work. Students who do not reach the minimum required score in the laboratory work must take a written test on the practical content.

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). Wide range of applications and features that allow the study, drawing, formulation, modeling, and editing of chemical and biological molecular structures.

(Other books may contain basically the same information: check with the professor.)

ADDITIONAL

- Molecular models. A tool for studying the three-dimensional structure of molecules. Different types of models can be found. http://www.sinorg.uji.es/docencia.htm