



Teaching Guide				
Identifying Data				2023/24
Subject (*)	Biochemistry I		Code	610G02011
Study programme	Grao en Bioloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	First	Basic training	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Bioloxía			
Coordinador	Rodriguez Belmonte, Esther	E-mail	esther.belmonte@udc.es	
Lecturers	Barreiro Alonso, Aida Inés De Castro De Antonio, María Eugenia Rey Souto, Cora Rodriguez Belmonte, Esther Saavedra Bouza, Almudena	E-mail	aida.barreiro@udc.es m.decastro@udc.es cora.rey.souto esther.belmonte@udc.es almudena.saavedra@udc.es	
Web	ciencias.udc.es/bcm			
General description	Biochemistry I is one of the main, and most dynamic, branches of Biology, which in turn stands as a bridge between the latter and Chemistry. As a basic discipline, the study of Biochemistry I is essential to understand the main chemical and structural properties of biological macromolecules and the relationship between these properties and the various functions they perform. It constitutes the starting point for the subsequent study of other related subjects.			

Study programme competences	
Code	Study programme competences
A8	Illar, analizar e identificar biomoléculas.
A30	Manexar adecuadamente instrumentación científica.
A31	Desenvolverse con seguridade nun laboratorio.
B1	Aprender a aprender.
B2	Resolver problemas de forma efectiva.
B3	Aplicar un pensamento crítico, lóxico e creativo.
B4	Traballar de forma autónoma con iniciativa.
B5	Traballar en colaboración.
B6	Organizar e planificar o traballo.
B7	Comunicarse de maneira efectiva nunha contorna de traballo.
B8	Sintetizar a información.

Learning outcomes			
Learning outcomes		Study programme competences	
Develop their ability to formulate and solve biochemical basic problems, relating the chemical and structural properties of biological molecules with their functionality.		A8	B2 B3
Know the main bibliographical sources in the field of biochemistry, that allows the student to find, select and understand information.		A8	B1 B8
Know the main characteristics of living matter from a molecular point of view: the main properties, chemical and structural of the biological macromolecules and the relationship between their properties and their functions. Also know the basic principles of bioenergetics and enzymology.		A8	B1 B2 B3 B8



Know the main techniques for the isolation, purification and characterization of the biomolecules.	A8	B2	
	A30	B4	
	A31	B5	
		B6	
		B7	

Contents	
Topic	Sub-topic
SECTION 1. INTRODUCTION TO BIOCHEMISTRY	<ol style="list-style-type: none"><li>1. Biochemistry, origins and evolution until the present</li><li>2. Biomolecules and Bioelements: Concept. Origins and Evolution of Biomolecules</li><li>3. Review of functional groups, chemical bonds and stereochemistry</li><li>4. Biomolecules in its aqueous environment</li></ol>
SECTION 2. BIOCHEMISTRY METHODOLOGY	<ol style="list-style-type: none"><li>1. General aspects of biochemistry methodology</li><li>2. Biological material used in biochemistry</li><li>3. Techniques tissue homogenate. Fractionation of cellular organelles</li><li>4. Fractional precipitation and centrifugation</li><li>5. Chromatographic techniques</li><li>6. Electrophoretic techniques</li><li>7. Dialysis and ultrafiltration</li><li>8. Radioactivity and isotopic techniques in biochemistry</li><li>9. Spectroscopic techniques</li></ol>
SECTION 3. CARBOHYDRATES	<p>Monosaccharides</p> <ol style="list-style-type: none"><li>1. Concept, classification and biological importance of carbohydrates</li><li>2. Configuration, conformation and cyclic structure of monosaccharides</li><li>3. Physical and chemical properties</li><li>4. Most important derivatives: structure and function</li></ol> <p>Oligosaccharides and polysaccharides</p> <ol style="list-style-type: none"><li>1. Properties of the O-glycosidic bond</li><li>2. Nomenclature, classification, structure, properties and biological significance of most important oligosaccharides</li><li>3. Analysis and identification techniques</li><li>4. Polysaccharides: concept and classification</li><li>5. Most important glucans: structure and biological function</li></ol>



SECTION 4. LIPIDS

Fatty acids, glycerides and glycerides

1. Concepts, classification and biological importance
2. Fatty Acids. General characteristics. Classification and nomenclature. Physical and chemical properties
3. Isolation and identification techniques
4. Fatty acid derivatives: Prostaglandins, thromboxanes and leukotrienes
5. Waxes. Definition, structure and biological function
6. Glycerides. Definition, structure and nomenclature. Properties and structural analysis

Phosphoglycerides and sphingolipids. Terpenes and steroids

1. Phosphoglycerides. Structure and classification. Properties and biological function
2. Sphingolipids: Phosphosphingolipids and glycosphingolipids. Structural analysis. Phospholipids and biological membranes
3. Terpenes. Structure, classification and nomenclature. Biological functions
4. Steroids. Structure, classification and nomenclature. Sterols, bile salts and steroid hormones: biological functions

Pyrrolic lipids

1. The pyrrole ring
2. Pirrolinic compounds: linear and cyclic pyrroles
3. Pyrrole compounds as members of conjugated proteins
4. Porphyrins and other pathologies



SECTION 5. AMINOACIDS, PEPTIDES AND PROTEINS

Amino acids: properties and purification

1. Structure, stereochemistry and classification of amino acid building blocks of proteins
2. Other amino acids
3. Physical and chemical properties of amino acids
4. Chemical reactivity of the amino acids
5. Purification and identification of amino acids

Primary structure of peptides and proteins

1. The peptide bond and its features. The amide bond. Physical and chemical properties of the peptides.
2. Nomenclature of peptides. Peptides of biological interest
3. Proteins: general characteristics. Concept. Classification criteria. Physical and chemical general properties
4. Structure levels of proteins
5. Primary structure of proteins. Concept of primary structure. Types of proteins according to their primary sequence

Secondary structure of proteins

1. Linus Pauling and Robert Corey. Concept of secondary structure
2. Alpha helix, beta sheets, and beta turns. Regions without secondary structure: Structural Features.
3. Prediction of secondary structures: Statistical methods
4. Stabilization of secondary structures

Spatial conformation of proteins

1. Concept of tertiary structure, supersecondary structure and domain
2. Stability of the three dimensional structure of proteins
3. Fibrous and globular proteins: characteristics and content in secondary and supersecondary structures and domains
4. Characteristics of protein folding
5. Quaternary structure of proteins

Protein properties. Extraction, purification and characterization

1. Physical properties. Denaturation and renaturation concepts: causes and effects. Protein absorbance at 280 nm
2. Chemical properties. Amphoteric character of proteins. Reactivity of the side chains of amino acids
3. Methods for determining protein concentrations
4. Methods of extraction, separation, purification and concentration of proteins
5. Methods for protein characterization: molecular weight, pI and number of monomers

Structural analysis of the proteins

1. Analysis of the primary structure. Analysis of amino acid composition and identification of the amino terminal residue
2. Automated sequencing of a short polypeptide: Edman degradation
3. Sequencing and automated protein synthesis
4. Localization of modified amino acid by mass spectrometry
5. Analysis of the secondary structures: circular dichroism
6. Analysis of the tertiary structure: X-ray diffraction and nuclear magnetic resonance



Conjugated proteins

1. Concept and types
2. Collagen
3. Hemeproteins: Types and structural and functional characteristics
4. Myoglobin and hemoglobin

Motor proteins and antibodies

1. Actin and myosin. General and structural characteristics
2. The Muscle contraction
3. General structure of immunoglobulins



SECTION 6. NUCLEOTIDES AND NUCLEIC ACIDS

Nucleotides

1. Nucleotides: definition, composition and general structure
2. Physical and chemical properties of bases
3. Important functional groups of the bases
4. Nucleotides as structural components of nucleic acids: phosphodiester bond
5. Nucleotides with other biological functions
6. Natural modifications and mutation of the bases

Deoxyribonucleic and ribonucleic acids

1. Definition and general characteristics of nucleic acids
2. Compositional and structural differences between DNA and RNA
3. Deoxyribonucleic acids: The DNA double helix and the tertiary structures of DNA. Structural characteristics of the different types of genomes
4. DNA sequencing techniques: The Sanger method
5. Ribonucleic Acids: François Jacob and Jacques Monod: theory of the information transport from DNA to protein. Types of RNA: function and structure

Properties and characterization of DNA and RNA

1. Denaturing agents: related to the temperature and pH
2. Loss of secondary and tertiary structure of nucleic acids: consequences
3. The  $T_m$  (melting temperature) and its relation to the length and nucleotide composition of the nucleic acids
4. Kinetics and monitorization of the denaturation-renaturation process: the hyperchromic effect of the denaturation
5. Hybridization concept: formation of pure and hybrid duplexes. Techniques: Southern and Northern blot

SECTION 7. PRINCIPLES OF BIOENERGETICS

1. Review of the thermodynamics principles applied to biological systems
2. Concept of coupled reaction and ATP cycle
3. Energy carrier molecules
4. Electron transporter molecules
5. Acetyl groups transporter molecules



SECTION 8. ENZYMOLOGY	<p>Enzymes as biological catalysts</p> <ol style="list-style-type: none"> <li>1. General characteristics and biological function</li> <li>2. Advantages of enzymes over chemical catalysts</li> <li>3. Classification of enzymes</li> <li>4. Reactions catalyzed by different classes of enzymes</li> <li>5. Cofactors, coenzymes and role of vitamins</li> <li>6. Principal reactions where the coenzymes are involved</li> </ol> <p>Action mechanisms of the enzymes</p> <ol style="list-style-type: none"> <li>1. Role of enzymes in biological reactions and metabolism</li> <li>2. Speed of reactions and activation energy</li> <li>3. Enzymes from the structural viewpoint. The active site: three dimensional structure and substrate recognition capability. Side chains of amino acids and catalysis</li> <li>4. Models that explain the activation energy decrease in the enzymatic reaction</li> <li>5. Review of heterolithic and homolithic reactions. Nucleophilic and electrophilic reagents</li> <li>6. Other molecules as biological catalysts: Antibodies as catalysts (abzymes), ribozymes, DNAzymes and Sinzymes</li> <li>7. Enzymes used in clinical analysis, in the diagnostic of diseases, or as therapeutic agents</li> </ol>
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Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student's personal work hours	Total hours
Guest lecture / keynote speech	B1 B3 B4 B6 B8	28	70	98
Laboratory practice	A8 A30 A31 B2 B5 B7	15	3.75	18.75
Problem solving	B1 B2 B4 B7	8	6	14
Workbook	B1 B6 B8	0.25	1	1.25
Mixed objective/subjective test	A8 B2 B3 B7 B8	2	10	12
Personalized attention		6	0	6
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The topics of the course will be taught by teachers and all presentations or other documentation will be made available to students on the Moodle platform.
Laboratory practice	A serie of activities will be conducted in the practical laboratory, so the students will learn how to handle basic scientific instrumental in Biochemistry and Molecular Biology.
Problem solving	In Moodle, the students will have a serie of questionnaires, tests practical problems to be solve individually as part of the continuous evaluation. Previously some of them will be solved in the seminar classes that will help the students to understand them.
Workbook	In each subject and/or thematic block the students will be recommended with a series of basic bibliographic readings, which they must consult previously of the Master Class, in order to encourage an active participation of the student.
Mixed objective/subjective test	<p>Written test used for the assessment of learning, whose distinctive trait is the ability to determine whether the answers are correct or not. It is a measuring instrument rigorously developed, designed to measure knowledge, skills, abilities, performance, skills, attitudes, intelligence, etc. It applies to both the diagnostic, formative and summative assessment.</p> <p>The objective test can combine different types of questions: multiple choice questions, ordering, short answer, discrimination, complete and/or association. It can also contain a single type of any of these questions.</p>

### Personalized attention

Methodologies	Description
Problem solving Laboratory practice	<p>All the students would be orientated to resolve the problems and the practical cases.</p> <p>The schedule for the Tutoring hours would be specified at the beginning of the course. The students can also solicit a previous appointment to answer any question by e-mail.</p>

### Assessment

Methodologies	Competencies	Description	Qualification
Mixed objective/subjective test	A8 B2 B3 B7 B8	Evaluation of the Theoretical knowledge (test, definitions, related issues).	40
Problem solving	B1 B2 B4 B7	Evaluation of the resolution of practical cases.	40
Laboratory practice	A8 A30 A31 B2 B5 B7	<p>The practical classes at the laboratory will be considered as an MANDATORY assistance for passing the subject.</p> <p>The evaluation will consist of an objective test which will be included: specific practical cases related to the tests with Biomolecules, the use of different techniques and methods to quantify and identify these, as well as the management of the equipment used during the various practical classes.</p> <p>They will be evaluated also the ability to graph data, interpretation of results, also their discussion, which will be the necessary condition to use a correct scientific language.</p>	20

### Assessment comments

Laboratory practical classes Laboratory practical classes are compulsory. Those students who do not carry out ALL laboratory practices, and do not present a proper justification, will not overcome the subject.

1st OPPORTUNITY QUALIFICATION (JUNE) To overcome this subject it will be necessary to achieve, at least, 45 out of 100 of the points in each of the assessable activities: Objective Test, Problem solving and Laboratory practice. Otherwise the three activities cannot be compensated among them. 2nd OPPORTUNITY QUALIFICATION (JULY) The students are required to obtain a final grade of at least 45 out of 100 in each of the three activities to pass this subject. Final Qualification Records (QRs)

QRs will be the sum of the points achieved in the three assessable activities in both (June and July) opportunities. In those cases in which any of the three activities, the 45% of the points are not achieved, the Final QRs will be the score of 4. DECEMBER EVALUATION: It will consist of a global examination of theoretical and practical contents with a value of 80% and an examination of practices with a value of 20% of points. The realization of the practices is compulsory so the students will have to have done them in previous courses. The total score must be 50% of the points or more to pass the subject. CONSIDERATION OF NOT PRESENTED (NP) or ?No Show?: -1st Opportunity (June): Those students that do not take the objective test in the official exam will be considered as NP.

-2nd Opportunity (July): NP will be applicable to those students that do not take ANY of the parts in the official exam. STUDENTS WITH PART-TIME AND ACADEMIC EXEMPTION:

For students with part-time dedication and attendance exemption, in the

June and July call there will be a specific global evaluation exam, being the laboratory

practicals mandatory in any case. HONOURS (Matrícula de Honor): The highest mark available and awarded will be only for those students who have demonstrated an excellent performance in the 1st Opportunity (June) 2nd OPPORTUNITY QUALIFICATION (JULY) FRAUDULENT

ACTIVITIES: In the situation that any fraudulent activity

is observed during tests or evaluation activities, the measures established in

current University regulations will be taken





## Sources of information

<b>Basic</b>	<ul style="list-style-type: none"><li>- Feduchi, E., Blasco, I., Romero, C.S. y Yáñez, E. (2010). Bioquímica. Conceptos esenciales. 1ª ed.. Editorial Médica Panamericana</li><li>- Albert L. Lehninger, David L. Nelson, Michael M. Cox. (2001). Lehninger Principios de Bioquímica. 3ª ed. . Ed. Omega</li><li>- Stryer, L., Berg, J.M. y Tymoczko, J.L. (2013). Bioquímica, 7ª ed.. Ed. Reverté</li><li>- Mathews CK, Van Holde KE, Appling DR y Anthony-Cahill SJ (2013). Bioquímica, 4ª ed.. Ed. Pearson</li></ul>
<b>Complementary</b>	<ul style="list-style-type: none"><li>- Schmid, G.H. (1988). Química Biológica. Las bases químicas de la vida.. Ed. Interamericana/McGraw-Hill</li><li>- Segel, I.H. (1982). Cálculos de Bioquímica. 2ª ed.. Ed. Acribia.</li><li>- Smith, C. A. y Wood, E. J. (1997). Moléculas biológicas. . Ed. Addison-Wesley Iberoamericana.</li><li>- Voet, D. y Voet, J.G. (1992). Bioquímica.. Ed. Omega</li></ul> <p>Recursos web: Biomodel: Modelos moleculares en movimiento e interactivos que, junto con texto explicativo, ilustran la estructura tridimensional de las biomoléculas. Autor: Ángel Herráez Sánchez Estructura de macromoléculas: Modelo interactivo para profundizar en las estructuras macromoleculares: desde un enlace peptídico hasta una membrana biológica. Autor: Jesús M. SanzAula Virtual de Biomoléculas: Herramientas para conocer mejor las biomoléculas. Autor: José Luis Urdiales Ruiz Cibertexto de Biomoléculas: Un curso completo de la estructura de las biomoléculas (glúcidos, lípidos, proteínas y ácidos nucleicos) con la posibilidad de autoevaluarse. Autor: Juan Manuel González MañasMATERIALES MULTIMEDIA Y BIOMOLÉCULAS: Material docente para el primer, segundo y tercer ciclo Autores: Pilar Roca, Jordi Oliver y Sergio Rodríguez Enlaces: Colección de enlaces sobre Bioquímica y Biología Molecular en español y otros idiomas en el mundo. Recopilador: Ángel Herráez Sánchez Outros materiais de apoio: Materiales disponibles en la página web de la asignatura. CD-Rom: BioROM 2011 Ayudas al aprendizaje de la Bioquímica, Biotecnología y Biología Molecular</p>

## Recommendations

### Subjects that it is recommended to have taken before

Chemistry/610G02001

Mathematics/610G02003

Biology: Basic Levels of Organisation of Life I (Cells)/610G02007

### Subjects that are recommended to be taken simultaneously

Physics/610G02002

Statistics/610G02005

Biology: Basic Levels of Organisation of Life II (Tissues)/610G02008

### Subjects that continue the syllabus

Biochemistry II/610G02012

Biochemistry and Molecular Biology/610G02013

Biochemical Foundations of Biotechnology/610G02014

### Other comments



## Gender Perspective

According to the different regulations applicable to university teaching, the gender perspective must be incorporated in this subject (non-sexist language will be used, bibliography of authors of both sexes will be used, the intervention of male and female students in class will be encouraged...).

We will work to identify and modify sexist prejudices and attitudes and will influence the environment to modify them and promote values of respect and equality.

Situations of gender discrimination should be detected and actions and measures will be proposed to correct them.

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## Green Campus Program Faculty of Sciences

To help achieve an immediate sustainable environment and comply with point 6 of the "Environmental Statement of the Faculty of Science (2020)", any documentary homework to be carried out in this subject:

a. They will be requested mostly in virtual format and computer support.

b. If on paper:

- No plastics will be used.
- Double-sided printing shall be used.
- Recycled paper shall be used.

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Drafts shall be avoided.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.