

	PROCESO PARA EL DESARROLLO DE LAS ENSEÑANZAS DE LA FACULTAD DE CIENCIAS DE LA UEX		
	Curso académico: 2025-2026	Código: P/CL009_FC_D002	

COURSE SYLLABUS

Identification and characteristics of the course					
Code	502678				
Course name (English)	Structural Biochemistry				
Course name (Spanish)	Bioquímica Estructural				
Degree programs	Biotechnology				
Faculty/School	Facultad de Ciencias				
Semester	3 rd				
Module	Core subject				
Matter	Biochemistry	ECTS	6	Term	3
Lecturer/s					
Nombre	Despacho		Correo-e		
Francisco de Asís Iñesta Vaquera	DBQ9		finestavaquera@unex.es		
Course area	Biochemistry and Molecular Biology				
Department	Biochemistry and Molecular Biology and Genetics				
Coordination					
Competences / Learning outcomes					
<p>1. Basic competences:</p> <p>CB1: Demonstrate knowledge and understanding in a field of study that starts from general secondary education, including aspects from the forefront of the discipline.</p> <p>CB2: Apply knowledge professionally and possess problem-solving skills within the field of study.</p> <p>CB3: Gather and interpret relevant data to make judgments on social, scientific, or ethical issues.</p> <p>CB4: Communicate information, ideas, problems, and solutions to both specialized and non-specialized audiences.</p> <p>CB5: Develop learning skills necessary for autonomous postgraduate study.</p>					
<p>2. General Competencies</p> <p>CG1: Ability to effectively pursue postgraduate studies in teaching, research, or professional fields.</p> <p>CG2: Ability to independently acquire and process information related to biotechnology.</p> <p>CG3: Ability to plan, execute, and critique knowledge processes in their field.</p> <p>CG4: Apply basic science and technology knowledge to biological and health systems.</p> <p>CG5: Identify, formulate, and solve problems in broad, multidisciplinary contexts.</p> <p>CG6: Analyze and assess the social and environmental impact of technical solutions.</p> <p>CG7: Solve problems with initiative, autonomy, and creativity.</p> <p>CG8: Apply theoretical learning to practical contexts.</p> <p>CG9: Self-evaluate and commit to continuous learning.</p>					
<p>3. Transversal Competencies</p> <p>CT1: Apply academic knowledge professionally and safely in the lab.</p> <p>CT2: Use ICT tools for academic and professional purposes.</p> <p>CT3: Understand advanced textbooks and access cutting-edge knowledge.</p> <p>CT4: Develop learning, organization, and planning skills.</p> <p>CT5: Analyze and synthesize relevant data to form critical judgments.</p>					

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CT6: Communicate results and conclusions effectively.
 CT7: Master native language communication and sufficient proficiency in a foreign language (preferably English).
 CT8: Lead or work in teams in various contexts.
 CT9: Respect fundamental rights, gender equality, life, and the environment.

4. Specific Competencies

CE2 - Understand the structure and function of cells and tissues.
 CE3: Understand the basic principles that determine the molecular structure and chemical reactivity of simple biomolecules.
 CE4: Understand the principles that determine the structure of biological macromolecules and explain structure-function relationships.
 CE5: Understand chemical and thermodynamic principles of molecular recognition and biocatalysis, including enzymatic function.
 CE6: Understand membrane structure and roles in transport, energy transduction, and signal transduction.
 CE7: Understand and know the structure and organization of genetic material, genomes, and genetic code.
 CE8: Understand physiological processes in multicellular organisms and their molecular bases.
 CE10: Have an integrated view of cellular function, covering regulation and compartment relationships.
 CE11 - Understand and understand the fundamentals of cellular and molecular immunology.
 CE12 - Understand the main current problems and future challenges of the Biosciences, as well as the ethical and social implications of the practical applications of the Biosciences in the healthcare and biotechnology sectors.

Contenidos

Descripción general del contenido:

In this course, we will address the structures of two groups of biomolecules: proteins and nucleic acids, always from the perspective of the relationship between these structures and the functions these biomolecules perform. We will also address a biotechnological perspective, delving into how to modify these biomolecules, preserving their structure and function while increasing their stability and even acquiring new functionalities that allow for new applications.

Temario de la asignatura

Topic 1: Introduction.

Contents of Topic 1: Structural Biochemistry as part of Biochemistry and Molecular Biology. Structure-function relationships in biomolecules. Weak interactions: types of non-covalent bonds.

Description of the practical activities for Topic 1: These are related in assignments 1 and 2 of the practical sessions.

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Topic 2: Covalent structure of proteins.

Contents of Topic 2: Structure and physicochemical properties of amino acids. Peptide bond: properties. Secondary structure of proteins. Structural motifs: supersecondary structures.

Description of the practical activities for Topic 2: These are related in assignments 1, 2, and 3 of the practical sessions.

Topic 3: Tertiary and quaternary structures of proteins.

Contents of Topic 3: Structure of globular proteins: α domains. α/β domains. β domains. Structure of membrane proteins, transmembrane domains.

Description of practical activities for topic 3: These are related to assignments 1, 2, and 4 of the practical activities.

Topic 4: Protein folding and stability.

Contents of topic 4: Conformational states: thermodynamics and stability. Protein folding pathways. Enzymes involved in protein folding: proline peptide isomerases, disulfide bond isomerases, folding tutor proteins. Description of practical activities for topic 4: These are related to assignments 3 and 4 of the practical activities.

Topic 5: Conformational dynamics, ligand-protein interactions.

Contents of topic 5: Allosteric effectors and conformational states. Nucleotide binding sites, calcium binding sites, ion channels, membrane transporters. Location of functional centers.

Description of the practical activities for topic 5: These are listed in assignments 4 and 5 of the practical sessions.

Topic 6: Methods for studying protein structure.

Contents of topic 6: UV, visible, and fluorescence spectroscopy. Circular dichroism. Infrared spectroscopy. Nuclear magnetic resonance. Protein crystallization and X-ray diffraction.

Description of the practical activities for topic 6: These are listed in assignments 3 and 5 of the practical sessions.

Topic 7: Protein structure prediction.

Contents of topic 7: Sequence homology and structure assignment. Secondary structure prediction. Tertiary structure prediction: reverse folding, ab initio methods.

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Description of the practical activities for topic 7: These are listed in assignment 4 of the practical sessions.

Topic 8: Engineering and design of more stable proteins or proteins with new functions (chimeras).

Contents of Topic 8: Conformational entropy, folding enthalpy, and the hydrophobic effect. What can be modified and why. Construction of proteins with new functions, domain fusion. Biotechnological applications of protein improvement.

Description of the practical activities for Topic 8: These are listed in assignments 2 and 4.

Topic 9: Structure of nucleic acids.

Contents of Topic 9: Physicochemical properties of nucleosides and nucleotides. Primary structure and structural parameters.

Description of the practical activities for Topic 9: These are listed in assignment 4.

Topic 10: Double-helix structures.

Contents of Topic 10: Double-helix families: A, B, and Z. DNA flexibility and curvature. DNA supercoiling. DNA triple helix.

Description of the practical activities for Topic 10: These are listed in assignment 4 of the practical lesson.

Topic 11: DNA-Protein Interactions.

Contents of Topic 11: Methods of Protein Binding to DNA. Study Techniques. Specific Sequence Recognition in B-DNA. Structural Motifs of Recognition Proteins. Helix-Turn-Helix. Zn²⁺ Fingers. Leucine Zippers.

Description of the practical activities for Topic 11: These are listed in assignments 4 and 5 of the practical lesson.

Title of Topic 12: The Ribosome as a Model of RNA-Protein Interactions.

Contents of Topic 12: Structure of rRNA and Ribosomal Proteins. Structure of Translation Factors. Domains in tRNA.

Description of the practical activities for Topic 12: These are listed in assignments 4 and 5 of the practical lesson.

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Practical Class Schedule.

Task 1: Purification and characterization of a recombinant human protein in bacteria.

Task 2: Purification and characterization of a mutant of the above recombinant human protein in bacteria.

Task 3: Study of its structures using electrophoretic and fluorescence techniques.

Task 4: Modeling of the tertiary and quaternary structure.

Task 5: Ligand-receptor interaction media using fluorescence techniques.

Teaching activities

Student workload in hours by lesson		Lectures	Practical activities				Monitoring activity	Homework
Topic	Total	L	HI	LAB	COM	SEM	SGT	PS
1	2	1						1
2	7	3						4
3	13	5						8
4	11	4					1	6
5	10	4						6
6	12	4						8
7	10	4						6
8	13	3		5				5
9	15	2		5			1	7
10	17	4		5				8
11	10	4						6
12	10	4						6
Assessment	20	3						17
TOTAL	150	45		15			2	88

L: Lectures (85 students)

HI: Hospital internships (7 students)

LAB: Laboratory or field practices (15 students)

COM: Computer room or language laboratory practices (20 students)

SEM: Problem classes or seminars or case studies (40 students)

SGT: Scheduled group tutorials (educational monitoring, ECTS type tutorials)

PS: Personal study, individual or group work and reading of bibliography

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Teaching Methodologies

1. Explanation and discussion of content.
2. Problem-solving, analysis, and discussion via the virtual classroom.
3. Completion, presentation, and defense of papers/projects.
4. Experimental activities such as laboratory practice and protein and nucleic acid modeling using bioinformatics tools.
5. Individual or group follow-up activities.
6. Independent student work.

Learning outcomes

- Understand the principles that determine the structural stability and flexibility of the main biological macromolecules, proteins, and nucleic acids.
- Understand the levels of structural organization of proteins and nucleic acids. Understand the structural and functional characteristics of the main types of protein domains. Understand protein folding processes, their study methods, and their relationship to structural prediction.
- Understand the principles that govern the interactions between nucleic acids and proteins, including knowledge of the structural details and mode of action of the main families of transcriptional regulatory proteins.
- Understand at the structural and molecular level the energy transduction processes in biological processes.

Assessment approach

Continuous assessment.

Theoretical classes.

The theoretical component will be assessed through a single exam. This exam will consist of three parts: one with essay questions, which will be weighted out of 5 points, another with short-answer questions, which will be weighted out of 3 points, and a third with true/false answers, which will be weighted out of 2 points. If the final grade is 5 or higher, it will contribute 60% of the final grade.

Demonstrations assessment.

Demonstrations will be assessed through a written research-type assignment. Attendance and passing of demonstrations will be an essential requirement to be able to sit the theoretical exams. If passed, the practical grade will contribute 15% of the final grade.

Other assessed activities.

Group projects aimed at modifying proteins and/or nucleic acids to acquire biotechnologically relevant functionalities. The projects will be presented and discussed by the entire class. This section will constitute 25% of the final grade.

Overall Assessment.

Taking into account the Assessment Regulations for Official Degrees of the University of Extremadura (DOE no. 212, of November 3, 2020), there will be an alternative comprehensive final exam (theory,

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demonstrations, and presentations) for those students who choose overall assessment, so that passing this exam implies passing the subject.

Bibliography (basic and complementary)

- Kuriyan, J., Konforty, B., Wemmer, D. The Molecules of Life. Garland Publishing, 2013.
- Steven, A.C., Baumeister, W., Johnson, L.N., Perham, R.N. Molecular Biology of Assemblies and Machines. Garland Publishing, 2016.
- Branden, C., Tooze, J. Introduction to Protein Structure. 2nd Edition, Garland Publishing, 1999.
- Kyte, J. Structure in Protein Chemistry. Garland Publishing, 1995.
- Bahar I., Jernigan R.L., Dill K.A. Protein Actions. Principles & Modeling. Garland Science, 2017.
- Lesk, A.M. Introduction to Protein Architecture. Oxford University Press, 2001.
- Calladine, C.R., Drew, H.R., Luisi, B.F., Travers, A.A. Understanding DNA. 3rd Edition, Elsevier, 2004.
- Van Holde, K.E., Johnson, W.C., Ho, P.S. Principles of Physical Biochemistry. Prentice Hall, 1998.

Additional resources and complementary materials

Online resources:

- <http://www.rcsb.org/pdb/home/home.do>
- <http://www.ncbi.nlm.nih.gov/genbank/>
- http://www.expasy.org/structural_bioinformatics
- <http://www.ncbi.nlm.nih.gov/protein>
- <http://www.ebi.ac.uk/>
- <https://www.predictprotein.org/>