Structure and Function of Biomolecules

Code: 101916
ECTS Credits: 6

2024/2025

Degree	Type	Year
2501230 Biomedical Sciences	FB	1

Contact

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

There are no official prerequisites to follow the course successfully. Nonetheless it would be desirable if students were familiar with basic knowledge of biology and chemistry.

Much of the literature is in the English language, which is also used in the figures projected in theory classes.

To be able to attend the sessions of laboratory practices, the student must justify having passed the biosafety and security tests that will be found in the Virtual Campus and be knowledgeable and accept the operating regulations of the laboratories of the Faculty of Biosciences.

Objectives and Contextualisation

Objectives and Contextualization

The course Structure and Function of Biomolecules is the first part of the subject "Biochemistry" in the Biomedical Sciences degree; it covers the structural and functional characteristics of biomolecules from a point of view which is basic and simple but also with the necessary depth required for further use, mainly related to the structure and function of enzymes and the bioenergetics concepts that will be used in the second part of the subject to be taught in the third term under the name Biomolecules Metabolism. Similarly, the concepts on the structure and function of biomolecules are essential for the understanding of more specialized courses in the Biomedical Sciences degree.

Objectives:

- To understand, based on previously acquired chemistry knowledge, the fundamental structural characteristics of biological molecules, being able to draw conclusions about their stability, functionality and ability to replicate structures.
- To acquire the conceptual basis of bioenergetics processes as a primer to the second part of the subject Biochemistry, dedicated to metabolism.
- To understand the kinetics of enzymatic action in the context of the study of biological reactions and their metabolic relationships.
- To understand the basic methods of purification, characterization, structural analysis of biomolecules and recombinant DNA methodologies.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply knowledge acquired to the planning and implementation of research, development and innovation projects in a biomedical research laboratory, a clinical department laboratory or the biomedical industry.
- Display knowledge of the bases and elements applicable to the development and validation of diagnostic and therapeutic techniques.
- Display knowledge of the basic life processes on several levels of organisation: molecular, cellular, tissues, organs, individual and populations.
- Display knowledge of the concepts and language of biomedical sciences in order to follow biomedical literature correctly.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Analyse and solve problems on the application of methodologies for the cloning and characterisation of nucleic acids.
3. Calculate and interpret the kinetic and thermodynamic parameters that define enzyme reactions
4. Correctly use the terminology of biochemistry and its text and reference books.
5. Describe correctly the molecular mechanisms responsible for DNA replication and repair, RNA transcription and processing, mRNA translation and their regulation in prokaryotes and eukaryotes.
6. Describe the basic structural and functional characteristics of amino acids, proteins, glucids, lipids and biological membranes, nucleotides and nucleic acids.
7. Describe the biochemical principles behind folding, intracellular transit, post-translational modification and replacement of proteins, and give examples of the associated pathologies.
8. Describe the catalytic mechanisms of enzyme reactions and their inhibition and regulation mechanisms.
9. Describe the properties of the types of chemical bonding.
10. Describe the structure, function and regulation of proteins involved in oxygen transport and examples of their deficiencies involved in pathologies.
11. Distinguish between the principal organic compounds and their characteristics.
12. Explain the different methods for obtaining recombinant proteins.
13. Identify structural protein domains and modules and their functional and evolutionary relationships.
14. Interpret the parameters that define the binding of ligands to macromolecules.

15. Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
16. Select the most suitable experimental approaches for studying the structure and function of biomolecules.
17. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
18. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
19. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
20. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
21. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
22. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
23. Understand and critique scientific articles on biochemistry.
24. Understand the principles of acid-base balance.
25. Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Content

Content

THEORY

1. Introduction to the study of the structure and function of biomolecules.

The chemical logic of biological processes. Chemical elements present to living beings. Biomolecules Levels of structural organization of biomolecules. Biological importance of water. Non-covalent interactions in aqueous medium. Ionization of water, ion balance and shock absorber systems. Principles of Bioenergetics: the transformations of energy to living beings and the laws of Thermodynamics. Free energy and constant equilibrium. Most common biochemical reactions. Transfer of phosphate and ATP groups. Oxidation-reduction reactions.

2. Proteins: Primary structure and biological functions.

Protein classes and their functions. Structure and properties of amino acids. Stereoisomery and acid-base behavior. Peptides and peptide link. Analysis of the composition of amino acids and the sequence of proteins.

3. Three-dimensional structure of proteins.

General concepts about the structure of proteins. Secondary structure Helix α and leaves β. Fibrous proteins. Globular proteins Protein folding: factors that determine it. Molecular Chaperones. Introduction to conformational diseases. Prediction of the protein structure. Quaternary structure. Introduction to protein purification and characterization techniques.

4. Relation between structure and function in proteins: oxygen transporting proteins.

Storage and transport of oxygen: hemoglobin and myoglobin. Allosterism and cooperativity in hemoglobin. Myoglobin and hemoglobin s examples of protein evolution. Using protein sequences for the analysis of evolutionary relationships.

5. Biological catalyst, enzymatic kinetics and regulation.

What they are and how they work. Enzyme cofactors. Classification and nomenclature of enzymes. Effects ofcatalysts in chemical reactions. Examples of enzymatic mechanisms. Enzyme kinetics: the concept of initial velocity; Michaelis-Menten model. Enzyme inhibition. Regulation of enzyme activity: (inhibition), allosterism, covalent modification. Biomedical and biotechnological applications.

6. Carbohydrates.

Types of monosaccharides. Glycosidic and polysaccharide link. Glycoproteins and proteoglycans.

7. Lipids and biological membranes.

Types of lipids and functions. Biological membranes: composition, fluidity, asymmetry. Membrane proteins. Structure and function of lipoproteins and intracellular lipid bodies.

8. Nucleic acids. Levels of structural organization.

Nucleotides. Primary RNA and DNA structure. Secondary structure: Watson and Crick model and alternative structures. Tertiary structure: DNA transfer and supernatant RNA. Complex DNA-proteins: the eukaryotic nucleosome.

9. Replication and transcription of DNA.

Replication to prokaryotes. Differential features of eukaryotic replication: telomeres. DNA repair. Transcription to prokaryotes. Differential features of transcription to eukaryotes: RNA processing. Reverse transcription of RNA to DNA. Common principles and specific mechanisms for the regulation of gene expression in prokaryotes and eukaryotes.

10. The genetic code and the synthesis of proteins.

Genetic code Protein synthesis to prokaryotes and eukaryotes. Mechanisms to maintain the fidelity of the message to the translation process. Signals for intracellular localization of proteins. Post-translation modifications of proteins.

11. Recombinant DNA.

Restriction enzymes DNA cloning materials and methodology. Construction of DNA libraries. Selection and search for DNA sequences: hybridization. Sequence of DNA. Genome projects Chips to quantify gene expression. Some applications of genetic engineering.

PROBLEMS

This section will be based on a dossier that willbe delivered at the beginning of the semester consisting of a series of problems related to the topics developed in the theory lectures. The characteristics of the various parts of the syllabus theory impose a concentration of the problems proposed on certain specific aspects: chemical balance and buffer systems, free energy and equilibrium constant, purification methods and analysis of macromolecules, enzyme kinetics and recombinant DNA.

LABORATORY

Two four-hour sessions: PCR assay for detection and genotyping of CCR5 receptor, agarose gel analysis.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Laboratory practices	8	0.32	5, 12, 25
Problem sessions	10	0.4	2, 3, 24, 5, 8, 10, 12, 13, 14, 16
Theory sessions	36	1.44	5, 8, 10, 7, 6, 9, 11, 13
Type: Supervised			
Individual tutorials	2	0.08	23
Self-learning exercises and exercicies delivery through CV	14	0.56	2, 3, 24, 23, 5, 8, 10, 7, 6, 9, 11, 13, 16, 25, 4
Type: Autonomous			
Delivery of dossiers / practical sessions questionnaires	4	0.16	5, 12, 25
Group work for problem solving	15	0.6	2, 3, 24, 5, 8, 10, 13, 14, 16
Scientific seminars preparation	53	2.12	1, 22, 2, 23, 14, 21, 20, 17, 18, 16, 25, 4

"I hear and forget, I see and remember. I do and learn. " Chinese Proverb attributed to Confucius (551-470 BC). This maxim summarizes something quite accepted in the field of pedagogy, the best way to learn is trying to understand or solve a problem, with individual work or contributing to a group effort. A vital part to help maintain the motivation of the student must be a continuous evaluation of the effort made and its result, which will be discussed in the Evaluation section.

Given this, the main teaching emphasis will be placed in the supervised or autonomous activity section, either individual or group, so classroom lectures or classroom practices will be focused on providing basic minimum information and Questions (theory) that work more quantitatively in the classes of classroom practices and thus give critical answers in the form of work commissions that will be made accessible on a regular basis through the Virtual Campus.

Theory classes: will provide basic information accessible to the recommended reference book but will always have a certain interactive part of questions to the student. These questions will then be addressed in more detail in the sessions of problems, tutoring and Virtual Campus, thus reinforcing the basic concepts and strategies that you want to learn to repeat. The language of oral work will be Catalan (or Spanish if there are participations in this language). On the other hand, the main language in the query and main reference texts (reading) will be English. Written or oral participations will have an added value (see the Evaluation section) the use of the English language.

Scientific seminars: The students will work in small groups. They will prepare a Scientific seminar focused on the topic structure-function relationship and disease. They have to use consistent and evidence-based information for the preparation of the seminar. On the stablished dates they will present it to the rest of the class and solve the doubts of the audience.

Problem based learning: The group will be divided into two subgroups whose lists will be made public at the beginning of the course and each person will attend the sessions programmed by their group. At the beginning of the semester a dossier of statements of problems of the subject will be delivered through the Virtual Campus that will be resolved throughout the sessions. In a limited number of sessions distributed during the semester, the teachers of problems will expose the experimental and calculation principles necessary to work them, explaining the guidelines for their resolution and at the same time giving a part of the complementary subject to the classes of theory The problems will be prepared outside the class schedule, in work groups that will be maintained throughout the course. Additionally, new statements will be proposed that will have to work in groups in the same class and those who must deliver their resolution at the end of the session.

Laboratory practices are reduced to only two sessions, although an important part of practical training related to EFB will also be applied to another first subject (Laboratory I). These sessions should allow the student to

have a perspective of the distance between using critically data found in the scientific literature and producing them with their own hands.

In order to be able to attend the sessions of laboratory practices, the student must justify having passed the biosafety and security tests that he will find in the Virtual Campus and be knowledgeable and accept the rules of operation of the laboratories of the Faculty of Biosciences.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of dossiers / practical sessions questionnaires	15%	1	0.04	1, 3, 5, 12, 21, 20, 17, 18, 16, 25
Delivery of solved problems and in class resolution of exercicies	0,5%	1.5	0.06	2, 3, 24, 23, 5, 8, 10, 7, 6, 9, 11, 12, 13, 14, 21, 20, 17, 18, 16, 4
Partial test exams	55%	3	0.12	2, 3, 24, 23, 5, 8, 10, 7, 6, 9, 11, 12, 13, 14, 16, 4
Problems examination	15%	1	0.04	2, 3, 24, 23, 5, 8, 10, 7, 6, 9, 11, 12, 13, 14, 16, 4
Scientific seminars	10%	1.5	0.06	1, 22, 2, 3, 24, 23, 5, 8, 10, 7, 6, 9, 11, 12, 13, 14, 15, 21, 20, 19, 17, 18, 16, 25, 4

Evaluation

The evaluation of this subject will have the format of continuation. The purpose of evaluation continued (of which form part of the assessment of the evidence partial, the seminars and the deliveries a class of problems) is the encourage the efforts of the students in the long of all the topics , allowing monitor on its degree of monitoring and understanding of the subject .

Theory

Individual evaluation through :

- Two partial tests with test- type questions . No conditions are established for taking any of the scheduled tests .
- A test end of problems which will assess the global the problems worked on throughout the whole of the year , to assume a weight in the rating overall equivalent as only 10% of the grade, there will be recovery . The absence of the possibility of recovery for this last test means that it exists either a minimum of notice required to adopt globally the subject .
- A test final recovery of two exams partial , with the format of questions type test, aimed at those students that either or not they have been presented or not have received a rating of 3.5 in one of them or the two. This test is optional for thosewho want to improve the grade of the partials. The one who is present at this trial resignation to the rating obtained previously in the corresponding part.

To participate in the recovery, the student must have been previously evaluated in a set of activities the weight of which is equivalent to a minimum of two third parts of the qualification total of course.

Seminars:

Group evaluation.

- Presentation on group theme scientific interest and related to the relationship structure- function in disease .
- If it is done in English, a multiplier factor will be applied, that can mean a maximum of 0.5 additional points.
- The mark obtained in this seminar, initially the same for all the members of the group , can be weighted based on data from a questionnaire assessment that each student will do on the work of his group and his own.

The weight of the evaluation of seminars will be 10% of the total.

Problems

Group assessment with an additional individual assessment component:

- Group resolution of problems proposed in the classroom.

Individual assessment through:

- A final problem exam that will evaluate the overall problems worked on throughout the course, which will be held on the date set for the second partial theory exam.
- A recovery exam aimed at students who either couldn't attend the finalproblem exam or didn't achieve a score higher than 3.5. This exam is optional for those who want to improve their problem exam score. Those who take this exam will forfeit their previous score from the final problem exam.

The weight of the evaluation of problems will be 20% of the total: 0,5% corresponding to the evaluation group and 15% corresponding to the test end.

Practices

Group evaluation:

Presentation of the results obtained during the practices and resolution of the proposed questionnaire. Also take into account the attitude and behavior in the laboratory .

Attendance to the practices of the laboratory is mandatory. Only accepted changes of grupde exceptionally and always with justification documents. In case of not attending justified on any of the sessions of practices and there is no option to be assigned to a different group a group this session will not be considered in the calculation of the grade of practices.

The weight of the evaluation of practices will be 15% of the total.

Qualifications

The four sections are inseparable, so the student must participate, and be evaluated , in all of them in order to pass the subject. The rating end is calculated according to the parameters listed in the table below is presented so that the section of theory has generally 50% of the grade, Section of seminars 10%, the section of problems 20% and the internship the remaining 15% . To pass the course is requirement essential to have achieved a grade equal to or higher than 3.5 in each of the exams partial of theory. Once this requirement is met, the subject will be considered passed when the final grade is equal to or greater than 50 out of a maximum of 100.

Single assessment mode

- Students who have opted for the single assessment mode must take a final test consisting of an exam of the entire theoretical and problem syllabus of the subject. This test will take place on the same day that the students of the continuous evaluation take the exam of the second partial.

- The practical classes are of compulsory attendance and the students of the single assessment must take the exam and/or questionnaire on the same day as the students of the continuous assessment.

- The student's grade will be:

Subject grade = (Final exam grade - 85% + Laboratory grade - 15%)/100.

- If the final grade does not reach 5, the student has another opportunity to pass the course through the recovery exam to be held on the date set by the coordination of the degree. In this test 85% of the grade corresponding to the theory part can be recovered. The practical partis not recoverable.

Bibliography

Basic bibliography

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- Voet, D., Voet, J.G. "Biochemistry" (2010), 4rta ed. Wiley

- Voet, D., Voet, J.G, Pratt, C.W. "Fundamentos de Bioquímica". (2016), 4ª ed. Ed.Médica Panamericana. Barcelona

Exercises

- Textos com Lehninger, Mathews, Stryer contenen problemes al final de cada capítol.

- Stephenson F.H. (2012) Cáculo en Biología molecular y Biotecnología. 2ª ed. Ed. Elsevier España

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Bioquímica [Recurs electrònic] / Christopher K. Mathews, ... [et. al.] ; traducción: José Manuel González de Buitrago

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Bioquímica : con aplicaciones clínicas / Lubert Stryer, Jeremy M. Berg, John L. Tymoczko ; con la colaboración de Gregory J. Gatto, Jr. ; versión española por Miguel Ángel Trueba
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Voet, Donald
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Software

The use of the software detailed below is recommended for the preparation of scientific seminars:

- PyMol: https://pymol.org/2/

- Expasy: https://www.expasy.org/

Language list

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	511	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	512	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	513	Catalan/Spanish	first semester	morning-mixed
(SEM) Seminars	511	Catalan/Spanish	first semester	morning-mixed
(SEM) Seminars	512	Catalan/Spanish	first semester	morning-mixed
(TE) Theory	51	Catalan	first semester	afternoon