UAB
Universitat Autònoma de Barcelona

Structure and Function of Biomolecules

Code: 100758
ECTS Credits: 6

2024/2025

Degree	Type	Year
2500250 Biology	FB	1

Contact

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Teachers

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Teaching groups languages

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

Prerequisites

There are no official prerequisites. However, it is assumed that the student has assimilated the concepts acquired during the first term, particularly those contained in the subjects of Chemistry and Cell Biology, such as those related to chemical functional groups, chemical equilibrium, basic thermodynamics, biological membranes and cellular compartmentalization.

Objectives and Contextualisation

The course Structure and Function of Biomolecules is the first part of the subject "*Biochemistry*" in the Biology 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 *Biosignalling and Metabolism*. Similarly, the concepts on the structure and function of biomolecules are essential for the understanding of more specialised courses in the Biology 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.

Learning Outcomes

1. CM17 (Competence) Design processes and experiments using biochemistry and biotechnology techniques.
2. CM18 (Competence) Interpret the kinetic and thermodynamic parameters that define enzymatic reactions to provide innovative responses to the needs and demands of society.
3. KM30 (Knowledge) Describe the basic structural and functional characteristics of amino acids, proteins, carbohydrates, lipids and biological membranes, nucleotides and nucleic acids.
4. KM31 (Knowledge) Describe the catalytic mechanisms of enzymatic reactions and their inhibition and regulation mechanisms.
5. KM32 (Knowledge) Identify the specific bibliographic sources in biochemistry that allow, in an autonomous way, to develop and broaden the knowledge acquired.
6. SM27 (Skill) Apply the most appropriate experimental approaches to the study of the structure and function of biomolecules.

Content

THEORY

1. Introduction: elements, molecules, physical environment and bioenergetics of living beings.

The chemical logic of biological processes. Chemical elements in living species. Biomolecules: general characteristics. Biological importance of water. Non-covalent interactions in water. Ionization of water, ionic balance and buffer systems. Energy transformations in living organisms and the laws of thermodynamics. Free energy and equilibrium constant. Universal biochemical processes and reactions.

2. Proteins: primary structure and biological functions.

Classes of proteins and their functions. Structure and properties of amino acids. Stereoisomerism and acid - base behavior. Peptides and peptide bond. Protein sequence: analysis and evolutionary implications.

3. Three-dimensional structure of proteins.

General concepts. Secondary structure: α helices and β sheets. Tertiary structure: fibrous proteins and globular proteins. Protein folding and its determinant factors. Quaternary structure. Molecular chaperones; Proteasome. Introduction to conformational diseases. Protein structure prediction. Introduction to techniques for purification and characterization of proteins.

4. Structure-function relationship and evolution of 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 catalysts.

What they are and how they work. Enzyme cofactors. Classification and nomenclature of enzymes. Effects of catalysts 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. Structural characterization of macromolecules.

Spectroscopic methods and their applications; absorption spectroscopy, fluorescence, circular dichroism, infrared spectroscopy. Mass spectrometry. Determining the three-dimensional structure of macromolecules by NMR and X-ray diffraction.

7. Carbohydrates.

Types of carbohydrates and their functions. Monosaccharides: Description and properties. Derivatives of monosaccharides. Glycosidic bond. Oligosaccharides. Structural and storage polysaccharides. Glycoconjugates: glycoproteins, proteoglycans, and glycolipids. Carbohydrates as "informative" molecules.

8. Nucleic acids.

Basic concepts. Nucleotides. Primary structure of nucleic acids. Secondary structure: Watson and Crick model and alternative structures. Tertiary structure: DNA supercoiling and tRNA conformation. DNA-protein complexes: chromosome organization.

9. Recombinant DNA.

Brief introduction to nucleic acid metabolism: replication, transcription and translation. Materials and methods for DNA cloning: restriction enzymes, vectors, recombinant protein expression and purification methods. The most common methods of recombinant DNA technology. Applications to the production and modification of proteins. DNA sequencing and genome projects. Some applications of genetic engineering. Genomics and proteomics.

10. Lipids and biological membranes.

Lipid and functions. Lipid storage. Structural membrane lipids. Other lipids with specific biological activity. Lipoproteins. Structure and properties of biological membranes. Membrane proteins. Transport through membranes.

PROBLEMS

This section will be based on a dossier that will be 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:

1- Spectrophotometry as a method for determining the concentration of biomolecules. Preparation of buffer solutions.

2. Liquid chromatography and electrophoresis on SDS-polyacrylamide gels as methods for the analysis and purification of biomolecules.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practicals	8	0.32	CM17, SM27
Problem sessions	10	0.4	CM17, CM18, SM27
Theory sessions	32	1.28	CM17, CM18, KM30, KM31, KM32
Type: Supervised			
In-class tutorials	6	0.24	SM27
Self-learning exercises	5	0.2	CM17, CM18, KM32, SM27
Type: Autonomous			
Deliveries through the CV	7	0.28	CM17, CM18, KM32, SM27
Group work for problem solving	14	0.56	CM17, CM18, SM27
Individual or group study	60	2.4	CM17, CM18, KM30, KM31, KM32

The educational activities are divided into three sections: theory classes, problem-solving classes, and laboratory practices, each with its specific methodology. These activities can be supplemented with a series of tutorial sessions that can be scheduled additionally by mutual agreement between students and faculty.

Theory Classes

The professor will explain the course content with the support of audiovisual material, which will be available to students on the subject's Virtual Campus prior to the start of each course topic. These lecture sessions will constitute the most important part of the theory section. It is recommended that students have the printed material published on the CV to follow the classes more comfortably and that they regularly consult the books recommended in the Bibliography to complement the syllabus.

Theory classes will mainly take the format of lectures.

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 scheduled for their group.

At the beginning of the semester, a problem statement dossier for the subject will be delivered via the Virtual Campus, which will be solved throughout the sessions. In a limited number of sessions spread throughout the semester, the problem-solving faculty will present the experimental and calculation principles necessary to work on them, explaining the guidelines for their resolution and at the same time teaching part of the material that complements the theory classes.

Problems will be prepared outside of class hours, in working groups of four to five people that will remain throughout the course. Non-lecture face-to-face sessions will be dedicated to solving problems previously worked on in groups, which will be presented on the board by members of the different working groups. The faculty will ensure that all groups have the opportunity to publicly explain their problem-solving proposals throughout the semester and will occasionally collect the solution sheets for some of the problems. Additionally, new statements will be proposed to be worked on in groups in the same class, and their resolution must be submitted at the end of the session. At the end of the course, the members of the working group will also have to answer a questionnaire through the Virtual Campus where they will assess their own work and that of their group.

Laboratory Practices

The group will be subdivided into four subgroups, whose lists will be announced in advance. To ensure the smooth running of practical sessions, changes in groups will only be accepted if they are clearly motivated and previously accepted by the practical instructors. As a general rule, no changes will be accepted other than those involving the exchange of one student for another from a different group. It is necessary to attend the practices with a lab coat, splash-proof goggles, the printed and previously read practice protocol (available on the Virtual Campus), and a notebook to record observations and data obtained.

On the days established in the calendar, students enrolled in the Biochemistry laboratory will be summoned to carry out basic experiments in the determination of properties and the analysis of biomolecules. The practices, as well as their evaluation, will be carried out in groups of two people. After each session, a questionnaire with the experiment results and answers to the questions posed must be submitted. Attendance at the practices is mandatory, except in cases where there is a justifiable documented reason.

Tutorials

The scheduling of these sessions will always be at the request of the students, through their representatives, or at the proposal of the professor, as they are not explicitly scheduled in the academic calendar. The aim of these sessions, if held, is to resolve doubts, review basic concepts not explained in class, provide guidance on consulted information sources, and conduct debates on topics for which autonomous learning is scheduled or which have been proposed by the professors. These sessions will not be lectures, nor will they advance material from the official syllabus, but will be debate and discussion sessions. Their scheduling will be agreed upon with the class group so that the different sessions are evenly distributed throughout the syllabus.

Material Available on the Subject's Virtual Campus

- Teaching guide
- Presentations used by the faculty in theory classes
- Problem dossier
- Practice class protocols
- Additional self-learning documentation for theory classes (if necessary)
- Schedule of educational activities (classroom classes, laboratory classes, tutorials, evaluations, submissions...)
- Collection-model of multiple-choice questions (if necessary)

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%	0.5	0.02	CM18, KM32
Delivery of home-solved problems and in-class resolution of problems	9%	2	0.08	CM17, CM18, SM27
Delivery of self-learning exercises	5%	0.5	0.02	KM32
Mixed partial tests: multiple answer/short questions	60%	4.5	0.18	CM17, CM18, KM30,

				SM27
Problems examination	11%	0.5	0.02	CM18, KM31

The assessment of this subject will follow a continuous evaluation format with various types of monitoring: partial tests with multiple-choice and short-answer questions, in-person resolution of online mini-tests, submissions through the Virtual Campus, presentation and submission of problems in class, and practice sessions. The objective of continuous evaluation is to encourage student effort throughout the entire syllabus, allowing calibration of their level of tracking, understanding, and integration of the material. The following section presents the details of the evaluation methodology.

Theory

Individual assessment through:

Two partial tests with multiple-choice and short-answer questions. The multiple-choice questions will refer to the part of the syllabus covered in each of the partial exams. The short-answer questions will also refer to the respective parts, although to answer the questions in the second partial, it may be necessary to refer to previously covered concepts. Thus, the short-answer questions section allows for the evaluation of the integration of concepts and considers the subject as a unit of knowledge; this section will take a format equivalent to a comprehensive test in the second partial exam, where it will be assigned a higher weight in the final grade compared to the two previous partials. Each of the partial exams will account for 30% of the final grade of the subject.

Multiple-choice and short-answer questions will account for 75% and 25% of the partial exams' grades, respectively.

In conjunction with the second partial exam, the resolution of problems previously worked on in class will also be proposed as a complement to the evaluation of this teaching typology (see the Problems section).

The partial exams are eliminatory; therefore, those who have passed the theory exams after the second partial will have completed their evaluation of the subject.

There are no conditions for taking any of the scheduled tests.

The minimum grade to consider a partial exam is 4.0/10. See the Global Evaluation and Recovery Process section for an explanation of the overall course grade calculation, the minimum requirements to pass the subject, and the recovery process.

Submission of exercises and questions only through the Virtual Campus. This part will account for 5% of the final grade calculation.

In total, the weight of the theory section in the evaluation will be 65% of the total: 60% corresponding to the partial exams, and 5% corresponding to the submissions through the Virtual Campus.

Problems

Group assessment with an additional individual assessment component:

Resolution of problems worked on in groups throughout the course and presentation in class, scheduled so that all groups have the opportunity to solve exercises on the board. Group resolution of problems proposed in class. The grade obtained in these two sections, initially the same for all group members, may be weighted based on the data from an evaluation questionnaire that each student will complete about their group's work and their own.

Individual exam where some problems not previously addressed in class will be solved, and this will be done together with the corresponding second partial exam. The minimum grade to pass the problems exam is 4.0/10. The weight of the problems section in the evaluation will be 20% of the total: 9% corresponding to group assessment and 11% corresponding to the test proposed together with the second partial.

Practices

Group assessment:

Presentation of the results obtained during the practices and resolution of the proposed questionnaire. Additionally, attitude, practice execution, and behavior in the laboratory will be taken into account. Attendance at laboratory practices is mandatory. Changes of group will only be admitted in exceptional cases and always with documentary justification. In case of justified absence from anyof the practice sessions and no option to attend it in a different assigned group, that session will not be considered in the practice grade calculation.

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

Global Evaluation and Recovery Process

The three sections are inseparable, so students must participate and be assessed in all of them to pass the subject. The final grade is calculated according to the percentages explained above, with the theory section accounting for 65% of the grade, the problems section 20%, and the practices section the remaining 15%.

The subject will be considered passed when the following three conditions are met:

A minimum of 4.0 must be obtained in any of the individual exams to average with the rest of the grades. A minimum of 5 must be achieved in the overall theory grade to average with the rest of the grades (Overall theory grade = (Average of the two partials x 0.60 + Submission grade on the Virtual Campus x 0.05)/0.65). A grade of 5/10 must be achieved from the sum of the theory, problems, and practices sections. Those who do not meet these conditions will be called for a recovery test scheduled after the second partial exam. To participate in the recovery test, students must have been previously assessed in a set of activities whose weight is equivalent to at least two-thirds of the total subject grade.

The recovery test will contain multiple-choice questions corresponding to the partial exams of the subject and a written test of short-answer questions covering the entire subject. Those who take it must answer the multiple-choice questions from at least those partial exams where they did not achieve a 4.0/10 and also the short-answer section. However, they may choose to answer questions from other parts of the exam, in which case it will be assumed that they renounce the previous grade. An optional problem will also be proposed in this test, the grade of which will replace the one obtained during the second partial exam.

For the partials that do not need to be recovered, the grade from the initial multiple-choice part will be used. To proceed with the grade calculation of the subject and, therefore, to pass it, the overall theory grade after the recovery exam must be equal to or greater than 4. Otherwise, a grade lower than 5 or a "Not assessable" will prevent the final grade calculation and, consequently, it will appear in the students' records as failed.

The recovery test will also be open to grade improvement for those who decide to do so, which will mean that they renounce the previous grade and apply the rest of the conditions for those required to take it.

Other considerations

Those who cannot attend an individual assessment test for justified reasons (such as illness, the death of a first-degree relative, or an accident) and provide the corresponding official documentation to the Degree Coordination and the theory faculty will have the right to take the test on another date.

When the continuous assessment activities carried out have a weighting of less than 67% in the final grade, and therefore the affected persons are not in a position to take the recovery test, the qualification will be "Not assessable."

From the second enrollment of the subject, repeat students will not have to carry out the teaching activities or the assessments of those competencies already passed, which in this case consist of group work on cases/problems, practices, the submission of assignments through the Virtual Campus, and the online in-person tests. Competencies in the various parts will be considered passed if 50% or more of the corresponding grade is achieved.

Single Evaluation

Students opting for the single evaluation must complete the laboratory practices (PLAB) with mandatory attendance at the in-person sessions and it is a requirement to have them passed, with a weight of 20%.

The single evaluation consists of a single synthesis test with multiple-choice questions and short-answer questions on all the theory and problems program content. Additionally, on the day of the test, the problems proposed in class must be submitted, with a weight of 9% of the grade.

The grade obtained in the synthesis test is 72% of the final grade, that obtained in the practices 15%, and the classroom problems submission 9%.

The single evaluation test will be held on the same date set in the calendar for the second continuous evaluation test, and the same recovery system as for the continuous evaluation will apply.

To pass the subject, a final minimum grade of 5 points out of 10 is required.

Bibliography

Basic bibliografy and links:

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Software

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

JMol: http://jmol.sourceforge.net/

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	111	Spanish	second semester	morning-mixed
(PAUL) Classroom practices	112	Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	111	Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	112	Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	113	Catalan/Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	114	Catalan/Spanish	second semester	morning-mixed
(TE) Theory	11	Catalan/Spanish	second semester	afternoon