UAB
Universitat Autònoma de Barcelona

Basics of Biochemistry

Code: 106806
ECTS Credits: 6

2024/2025

Degree	Type	Year
2504602 Nanoscience and Nanotechnology	FB	1

Contact

Name: Irantzu Pallares Goitiz

Email: irantzu.pallares@uab.cat

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.

Part of the bibliography is in English, a language that is also used in the figures projected in the 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 accept the operating regulations of the laboratories of the Faculty of Biosciences.

Objectives and Contextualisation

In the subject Fundamentals of Biochemistry we study the structural and functional characteristics of biomolecules from a basic point of view, as it corresponds to a first course subject, but also with the necessary depth required because the knowledge acquired here , especially those referring to the structure of biomolecules and the function of enzymes, will be indispensable for other subjects of the Degree in Nanoscience and Nanotechnology, especially in the second year of the Metabolic Biochemistry and Molecular Biology, as well as the Bionanotechnology Mention.

Objectives of the subject:

- Objectives of the subject: Understand, based on previously acquired knowledge of Chemistry, the fundamental structural features of biological molecules, knowing how to draw conclusions about their stability, their functionality and their capacity for replication of structures .
- Understand the kinetic concepts of enzymatic action in the context of the study of biological reactions and their metabolic interrelations and how to apply the methodological tools studied in practical cases.
- Know the basic methodologies of purification, characterization and structural analysis of biomolecules.

Learning Outcomes

1. CM10 (Competence) Handle biological materials, reagents and chemical waste while following established protocols and assessing their economic and environmental impact.
2. CM10 (Competence) Handle biological materials, reagents and chemical waste while following established protocols and assessing their economic and environmental impact.
3. CM11 (Competence) Work collaboratively in teams to solve problems and practical cases in the field of biochemistry.
4. KM15 (Knowledge) Describe the composition, structure, properties and function of biomolecules.
5. KM16 (Knowledge) Describe the physical and chemical basis of proteins and their cellular functions.
6. KM17 (Knowledge) Describe the mechanisms of enzymes action and how they contribute to metabolic processes.
7. SM15 (Skill) Solve simple problems involved in enzyme kinetics.
8. SM15 (Skill) Solve simple problems involved in enzyme kinetics.
9. SM16 (Skill) Apply and explain the thermodynamic principles of bioenergetics.
10. SM16 (Skill) Apply and explain the thermodynamic principles of bioenergetics.
11. SM17 (Skill) Describe the basic methodologies involved in the purification, characterisation and structural analysis of biomolecules.
12. SM17 (Skill) Describe the basic methodologies involved in the purification, characterisation and structural analysis of biomolecules.

Content

THEORY

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

The chemical logic of biological processes. Chemical elements present to living beings. Biomolecules: general characteristics. Biological importance of water. Non-covalent interactions in aqueous medium. Ionization of water, ion balance and shock absorber systems. The transformations of energy to living beings and the laws of Thermodynamics. Free energy and constant equilibrium. Universal biochemical reactions and processes.

2. Proteins: functions and primary structure.

Types of proteins and functions. Structure and properties of amino acids. Classification Peptides and peptide link. Composition and sequence of amino acids of proteins. Sequence comparison. Database of sequences.

3. Three-dimensional structure of proteins.

Structuring levels of proteins. Description of alpha helix and beta folded leaf. Beta turns Fibrous proteins. Globular proteins Protein domains. Quaternary structure. Protein folding: factors that determine it; chaperones and prions. Conformational diseases. Database of protein structures. Prediction of the protein structure.

4. Purification and characterization of macromolecules.

Separation methods: centrifugation, chromatography, electrophoresis. Spectroscopic methods and their applications; Absorption spectroscopy, fluorescence, circular dichroism, infrared. Mass spectrometry. Determination of the three-dimensional structure of macromolecules by X-ray diffraction and nuclear magnetic resonance. Immunological methods.

5. Relationship between structure and function in proteins: oxygen transporting proteins.

Oxygen storage: myoglobin. Oxygen binding to myoglobin. Oxygen transport: hemoglobin. Cooperativity and allostericism of hemoglobin. Analysis of cooperativity. Allosteric effectors Different forms of hemoglobin:physiological adaptation and molecular pathology. Protein evolution.

6. Enzymes: general properties, catalysis mechanisms, enzymatic kinetics and regulation

General properties Classification and nomenclature of enzymes. Effects of catalysts on chemical reactions.Energy of activation and transition status. Enzymatic cofactors Enzyme-substrate coupling. Enzymatic mechanisms. Acid-base catalysis. Covalent catalysis. Catalysis for metal ions. Alcohol dehydrogenase. Electrostatic catalysis. Proximity and orientation effects. Enzymatic kinetics. Initial speed Units of enzymatic activity. Effect of enzyme concentration. Effect of the substrate concentration. Kinetic of the stationary state: Equation of Michaelis-Menten. Meaning of km, ks, kcat and kcat / km. Representation of Lineweaver-Burk.

Reactions bisubstrate: sequential mechanisms and double displacement (ping-pong). Piridoxal phosphate. Enzymatic inhibition. Reversible inhibition: competitive and non-competitive. Irreversible inhibition. Applications of enzymatic inhibition. Regulation of enzymatic activity. Changes in enzyme concentration. Regulation of protein degradation. Allosteric and allosteric enzymes. Isoenzymes Covalent modification (reversible and irreversible). Regulation for enzymatic cascade. Regulation of HMG-CoA reductase. Biomedical and biotechnological applications.

7. Carbohydrates.

Types of glucose and functions. Monosaccharides, description and properties. Glycosidic link Oligosaccharides. Polysaccharides Glycoconjugates: proteoglycans, glycoproteins and glycolipids. Glucids as molecules with information. The sugar code.

8. Lipids and biological membranes.

Types of lipids and functions. Fatty acids Reserve and membrane lipids. Cholesterol and derivatives. Liposoluble vitamins. Eicosanoids. Structure and function of lipoproteins. Biological membranes

9. Nucleic acids. Levels of organization.

Nature andfunction. Nucleotides, structure and properties. Primary structure of nucleic acids. Secondary structure: Watson and Crick model and alternative structures. Secondary and tertiary structure of the RNA. Transfer RNA. DNA overgrowth. DNA denaturation. DNA-proteins complexes: organization of the chromosome. Recombinant DNA technology. Genomics and proteomics.

PROBLEM-BASED LEARNING

This section will be based on the dossier that will be presented at the beginning of the semester, consisting of a certain amount of statements of problems related to the topics developed in Theory. The characteristics of the various parts of the Theory's agenda make the statements of the problems concentrate on certain aspects that are: chemical equilibrium and shock absorber systems, purification and macromolecular analysis methods, and enzymatic kinetics.

LABORATORY PRACTICES

There will be three laboratory sessions of four hours each one:

- Spectrophotometry as a method for the determination of the concentration of biomolecules. Preparation of a dissolving solution.

- Liquid chromatography and electrophoresis in SDS gels as methods for analysis and separation of biomolecules.

- Enzymatic test and experimental determination of parametrinic acids. Enzymatic inhibition.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes

Type: Directed		
Laboratory practicals	12	0.48
Problem sessions	8	0.32
Scientific seminars	4	0.16
Theory sessions	27	1.08
Type: Supervised		
Individual tutorials	3.5	0.14
Type: Autonomous		
Group work for problem solving and seminars	15	0.6
Individual or group study	70	2.8

The training activities are divided into four sections: theory classes, scientific seminars, problem-based learning and laboratory practices, each one with its specific methodology.

Theory classes

The content of the theory program will be taught mainly by the teacher in the form of master classes with audiovisual support. Presentations used in class by the teacher will be previously available on the Virtual Campus of the subject. It is recommended that students take this material to class, to use it as a support when taking notes. It is recommended that students regularly consult the books recommended in the Bibliography section of this Teaching Guide in order to consolidate and clarify, if necessary, the contents explained in class.

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

If it is done in English, a multiplier factor is chosen, assuming a maximum of up to 0.5 additional points.

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 tothe 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

The class will be divided into subgroups, whose lists will be announced in advance. In order to ensure the smooth running of the practical sessions, only changes in the groups that are clearly motivated and accepted by the practice practitioners will be accepted. As a general rule, they will not be accepted other than those that

involve the change of a student by another from a different group. It is necessary to appear in the practices with a lab coat, splash protection goggles, the protocol of practices (available on the Virtual Campus) printed and previously read and a notebook to write down the observations made and the data obtained.

On the established dates, the students will be summoned to the Biochemistry laboratory to carry out basic experiences in the determination of properties and in the analysis of biomolecules.

The practices, as well as their evaluation, will be carried out in groups of two or three people. Once the three sessions have finished, a questionnaire will be submitted with the results of the experiments and the answers to the questions posed. The attendance to the practices is obligatory, except in cases where there is a documented just cause.

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 dosiers / practical sessions questionnaires	15%	2	0.08	CM10, CM11, KM15, KM16, KM17
Delivery of solved problems	5%	1	0.04	CM11, KM15, KM16, KM17, SM15, SM16, SM17
Problems examination	15%	1	0.04	SM15, SM16, SM17
Scientific seminars	10%	1.5	0.06	CM11, KM15, KM16, KM17, SM17
Theory partial and final exams	55%	5	0.2	KM15, KM16, KM17, SM16, SM17

THEORY

Individual assessment through:

-Two eliminatory partial tests with test questions. You need get a score equal or greater than 3.5 in each partial to be able to release the corresponding part of the content without going to the recovery exam.

-A final test of recovery of the two partial examinations, with the format of questions of type test. The student is obligated to submit to the recovery of the partial that has not passed with a mark of 3.5 or higher. This test is optional for anyone who wants to improve the note of the partial ones. Remarkably, the student that presents to this test resigns to the qualification previously obtained in the corresponding partial one. To participate in the recovery, the students must have been previously evaluated in a set of activities whose weight equals to a minimum of two thirds of the total grade of the subject.

The weight of the theory evaluation will be 55% of the total.

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 is chosen, assuming a maximum of up to 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 component ofindividual assessment:

Group assessment:

- 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 final problem 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: 5% corresponding to the group evaluation and 15% corresponding to the final exam.

PRACTICES

Group evaluation:

• Presentation of the results obtained during the practices and resolution of the proposed questionnaire. You will also notice the attitude and behavior in the laboratory.

Attendance to laboratory practices is mandatory. Only group changes will be accepted inan exceptional way and always withdocumentary justification. In case of justified absence of any of the practice sessions and of not having the option of doing it in a group other than the one assigned, this session will not be considered in the calculation of the practice note. The students will obtain the "Not Evaluable" rating when the absence exceeds 20% of the programmed sessions.

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

FINAL MARK

The sections Theory, Seminars, Problems and Practices are inseparable, so the student must participate and be evaluated in all of them to pass the subject. Specifically, to pass the subject the student must have evaluated, at least, the two partial theory and / or the final exam, having participated in the group work of problems, seminars and having attended the practical sessions and delivered the questionnaires.

To pass the subject, it is necessary to obtain at least a 3.5 in the two partial theory tests and a global score equal to or greater than 5 points out of 10.

The students willobtain the "Not Evaluable" rating when the evaluation activities carried out have a weighting of less than 67% in the final grade.

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 part is not recoverable.

Bibliography

Basic bibliography

- Mathews, C.K., Van Holde, K.E., Appling, D.R., Anthony-Cahill, S.J. "Biochemistry" (2013) 4ª ed. Pearson Education

- McKee, T i McKee, J.R. "Bioquímica. La base molecular de la vida" (2009). 4ª edició. McGraw-Hill-Interamericana.

- Murray, R.K.i col. "Harper. Bioquímica ilustrada" (2013). 29ª edició. McGraw-Hill-Interamericana.

- Nelson, D.L. and Cox, M.M. "Lehninger-Principios de Bioquímica". (2018) 7ª. ed. Ed. Omega.

- Nelson, D.L. and Cox, M.M. "Lehninger-Principles of Biochemistry". (2017) 7ª. ed. Freeman, W. H. & Company

- Berg, J.M., Tymoczko,J.L., Stryer, L "Bioquímica" (2013). 7ªed. Ed. Reverté, Barcelona.

- Berg, J.M., Tymoczko,J.L., Stryer, L "Biochemistry" (2015) 8th ed. Macmillan

- Tymoczko,J.L., Berg, J.M.,, Stryer, L "Bioquímica. Curso básico". (2014). Reverté

- Horton, H.R., Moran, L.A. Scrimgeour, K.G. Perry M.D., Rawn J.D. "Principios de Bioquímica". 2008. 4ª ed. Prentice-Hall. Pearson Educación. México

- 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

Bibliography available in electronic format in the UAB catalog:

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

https://cataleg.uab.cat/iii/encore/record/C__Rb1965041
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
https://cataleg.uab.cat/iii/encore/record/C__Rb2043101

Bioquímica : curso básico / John L. Tymoczko, Jeremy M. Berg, Lubert Stryer ; [versión española traducida por: Juan Manuel González Mañas]
https://cataleg.uab.cat/iii/encore/record/C__Rb1927772
Bioquímica : las bases moleculares de la vida / Trudy McKee, James R. McKee ; traducción: Martha Elena Araiza Martínez, Anahí Hurtado Chong
https://cataleg.uab.cat/iii/encore/record/C__Rb2092731
Calculations for molecular biology and biotechnology / Frank H. Stephenson
https://cataleg.uab.cat/iii/encore/record/C__Rb2074081
Cálculo en biología molecular y biotecnología : guía de matemáticas para el laboratorio / Frank H. Stephenson ; traducción de: Jorge Lloberas Cavero, Annabel Valledor Fernández
https://cataleg.uab.cat/iii/encore/record/C__Rb2091253
Fundamentos de bioquímica [Recurs electrònic] : la vida a nivel molecular : 4a edición / Donald Voet, Judith G. Voet, Charlotte W. Pratt
Voet, Donald
https://cataleg.uab.cat/iii/encore/record/C__Rb1986458
Principios de bioquímica / H. Robert Horton [i 4 més] ; traducción Virgilio González y Pozo ; revisión técnica Leticia Bucio Ortiz [i 2 més]
Horton, H. Robert,
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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
(PAUL) Classroom practices	1	Catalan/Spanish	second semester	afternoon
(PAUL) Classroom practices	2	Catalan/Spanish	second semester	afternoon
(PLAB) Practical laboratories	1	Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	2	Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	3	Catalan/Spanish	second semester	morning-mixed
(PLAB) Practical laboratories	4	Catalan/Spanish	second semester	morning-mixed
(TE) Theory	1	Catalan	second semester	morning-mixed