Universitat Autònoma de Barcelona

2019/2020

Basics of Biochemistry

Code: 103277
ECTS Credits: 6

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	FB	1	2

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Alicia Roque Cordova

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.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.
- Communicate orally and in writing in ones own language.
- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Show sensitivity for environmental issues.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. Apply the theoretical contents of biochemistry to explain experimental phenomena.
2. Communicate orally and in writing in ones own language.
3. Correctly handle the usual material and instruments of a biochemistry laboratory.
4. Correctly observe protocols for the manipulation of biological materials, reagents and chemical waste.
5. Correctly perform calculations with biochemical reactions.
6. Correctly use English terminology for biomolecules and basic biochemistry matters.
7. Describe enzymatic kinetics and the mechanisms of inhibition.
8. Describe the catalytic mechanism of selected enzymes and some applications of enzymes.
9. Describe the chemical structure of amino acids, proteins, glucides, lipids, nucleosides and nucleic acids.
10. Describe the structure and function of nucleic acids.
11. Describe the structure of proteins, the physical and chemical bases of their folding and their different cellular functions.
12. Describe the structure, physical and chemical properties and functions of biological membranes.
13. Evaluate experimental biochemical results critically and deduce their meaning
14. Learn autonomously.
15. Manage the organisation and planning of tasks.
16. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
17. Perform bibliographic searches for biochemical documents.
18. Perform calculations related with enzymatic kinetics.
19. Perform calculations related with the ionisation equilibrium of biomolecules and pH.
20. Perform the basic separation and analysis procedures of a biochemistry laboratory.
21. Rationalise the results obtained in the laboratory in separation processes, property analysis and enzymatic reactions from theoretical knowledge of biochemistry.
22. Reason in a critical manner

23. Resolve biochemical problems with the help of the complementary bibliography
24. Resolve problems and make decisions.
25. Show sensitivity for environmental issues.
26. Work correctly with the formulas, chemical equations and magnitudes of biochemistry.

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.

Methodology

The training activities are divided into four sections: theory classes, problem-based learning and laboratory practices, each one with its specific methodology. These activities will be complemented by a series of tutoring sessions that will be programmed additionally.

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.

Problem-based learning

The group will be divided into two subgroups whose lists will be made public at the beginning of the year. Students 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

throughout the semester (three or four), problem professors will present the experimental and calculation principles necessary to work on the problems, explaining the guidelines for their resolution, and at the same time giving a part of the complementary subject to the classes of theory.

Students will work out problems outside class hours, in work groups of four to five people who will remain throughout the course. Non-expository face-to-face sessions will be devoted to the resolution of problems previously worked in groups during the previous week. In some sessions additional exercises will be given that will have to be solved in a group throughout the session. The problems giventhroughout thecourse will be taken into account in the final grade.

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.

Group tutorials

There will be 3 sessions of group tutorials, for the whole class, in which activities of content related to the partial tests will be carried out. The objective of these sessions will be to resolve doubts, review basic concepts and guide the sources of information consulted.

Individualized tutorials

Individual tutorials will be carried out at the request of the students.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practicals	12	0.48	1, 13, 2, 20, 15, 3, 25, 16, 21, 22, 5, 19, 18, 24, 26, 4, 6
Problem sessions	8	0.32	1, 14, 13, 2, 22, 5, 18, 23, 24, 26
Theory sessions	30	1.2	2, 9, 10, 11, 8, 7, 12, 16, 22, 6
Type: Supervised			
Gruop tutorials	3	0.12	2, 9, 10, 11, 8, 7, 12, 6
Individual tutorials	3	0.12	2, 9, 10, 11, 8, 7, 12, 22
Type: Autonomous			
Group work for problem solving	15	0.6	1, 14, 13, 17, 16, 22, 5, 19, 18, 23, 24, 26
Individual or group study	70	2.8	14, 13, 9, 10, 11, 8, 7, 12, 15, 16, 21, 22, 5, 19, 18, 23, 24, 26, 6

Assessment

THEORY

Individual assessment through:

-Two eliminatory partial tests with test questions. You need get a score equal or greater than 4.0 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 4.0 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 65% of the total.

PROBLEMS

Group assessment with an additional component of individual assessment:

- Resolution of problems delivered in groups throughout the course and evaluated by the teacher.
- Final maturity examination (individual) with one or two it will be done on the date set for the theory exam. You need to get a mark equal to or greater than 4.0 to add the mark of the examination of maturity of problems to the set of notes of the subject.
The weight of the evaluation of problems will be 20% of the total: 10% corresponding to the group evaluation and 10% 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, 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, and having attended the practical sessions and delivered the questionnaires.

To pass the subject, it is necessary to obtain a global score equal to or greater than 5 points out of 10, and the minimum grade of 4 in the two partial theory tests. If in any of these tests
The score is less than 4, the maximum overall score will be 4 points out of 10.

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

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of dosiers / practical sessions questionnaires	15%	2	0.08	1, 14, 13, 2, 20, 15, 3, 25, 16, 21, 22, 5, 19, 18, 23, 24, 26, 4, 6
Delivery of solved problems	10%	1	0.04	1, 14, 13, 2, 17, 16, 22, 5, 19, 18, 23, 24, 26
Problems examination	10%	1	0.04	1, 13, 22, 5, 19, 18, 26
Theory partial and final exams	65%	5	0.2	2, 9, 10, 11, 8, 7, 12, 22, 24

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.

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- 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. "Bioquímica". (2006), 3ª ed. Ed.Médica Panamericana. Barcelona

- 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

PROBLEMS

- 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