Universitat Autònoma de Barcelona

2019/2020

Structure and Function of Biomolecules

Code: 101916
ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	FB	1	1

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

Other comments on languages

All assessable participation in English, except the exam, will have a maximum multiplier factor of 1.2 and a minimum of 1

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

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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

- 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.
- Contribute to public discussions on cultural matters.
- Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
- Develop independent learning habits and motivation to continue training at postgraduate level.
- Develop independent learning strategies.
- Develop scientific knowledge, critical reasoning and creativity.
- 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.
- Generate innovative and competitive proposals for research and professional activities.
- Identify and understand the advances and challenges of research.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Respect diversity in ideas, people and situations.
- Show respect for the ethical and legal aspects of research and professional activities.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Analyse and solve problems on the application of methodologies for the cloning and characterisation of nucleic acids.
2. Calculate and interpret the kinetic and thermodynamic parameters that define enzyme reactions
3. Contribute to public discussions on cultural matters.
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. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
12. Develop independent learning habits and motivation to continue training at postgraduate level.
13. Develop independent learning strategies.
14. Develop scientific knowledge, critical reasoning and creativity.
15. Distinguish between the principal organic compounds and their characteristics.
16. Explain the different methods for obtaining recombinant proteins.
17. Generate innovative and competitive proposals for research and professional activities.
18. Identify and understand the advances and challenges of research.

19. Identify structural protein domains and modules and their functional and evolutionary relationships.
20. Interpret the parameters that define the binding of ligands to macromolecules.
21. Respect diversity in ideas, people and situations.
22. Select the most suitable experimental approaches for studying the structure and function of biomolecules.
23. Show respect for the ethical and legal aspects of research and professional activities.
24. Understand and critique scientific articles on biochemistry.
25. Understand the principles of acid-base balance.
26. 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.

Methodology

"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.

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 of four to five people that will be maintained throughout the course. The non-expository sessions will be devoted to the resolution of previously worked problems in a group, which will be exposed to the board by members of the different working groups. The teaching staff will ensure that all groups have the opportunity to publicly explain their problem-solving proposals throughout the semester and will sometimes pick up the resolution sheet for some of the problems. 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. 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 value their own work and that of their group.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	8	0.32	5, 16, 26
Problem sessions	10	0.4	1, 2, 25, 3, 5, 8, 10, 16, 19, 20, 22
Theory sessions	36	1.44	5, 8, 10, 7, 6, 9, 15, 19
Type: Supervised			
Individual tutorials	2	0.08	24, 14
Self-learning exercises and exercicies delivery through CV	14	0.56	1, 2, 25, 24, 3, 5, 8, 10, 7, 6, 9, 14, 11, 15, 18, 19, 22, 26, 4
Type: Autonomous			
Deliveries through the CV	53	2.12	14, 12, 11, 20
Delivery of dossiers / practical sessions questionnaires	4	0.16	5, 11, 16, 26
Group work for problem solving	15	0.6	1, 2, 25, 5, 8, 10, 19, 20, 22

Assessment

Evaluation

The evaluation of this subject will have the format of continued with a final test of set. The objective of the continuous evaluation (of which part-test assessments, deliveries through the CV and deliveries to problem class are included) is to encourage the student's effort throughout of the whole agenda, allowing to monitor its degree of follow-up and understanding of the subject. The final set test is used to verify that the student has achieved the necessary degree of integration of knowledge of the subject.

Theory

Individual assessment through:

Two partial tests with test questions. There are no conditions to submit to any of the scheduled tests.
A final set of tests with the format of short answer questions and which will cover the entire subject of the subject. This final test will be done in conjunction with the second part of test questions and with a test of problems. It should be noted that the final test of set + problems, assuming a weight in the overall grade equivalent to only 20% of the note, will not be recovered. The absence of the possibility of recovery for this last test means that there is not a minimum of required grade to be able to approve the subject globally.
A final test of recovery of the two partial examinations, with the format of questions of type test, aimed at those students who, either could not present or have not obtained a note greater than 4.0 in one of them or in both. This test is optional for those who want to improve the partial note. Those who submit to this test waive the previous qualification obtained in the corresponding partial
The weight of the theory evaluation will be 65% of the total.

Problems

Group evaluation with an additional component of individual assessment:

Resolution of the problems worked in groups throughout the course and exposition in class, arranged so that all groups have the opportunity to solve exercises on the board.
Resolution in group of problems proposed in the classroom.
The note obtained in these two sections, initially the same for all the members of the group, may be weighted based on the data of an evaluation questionnaire that each student will do about the work of his group and his own.
Individual examination where one or two problems previously resolved in class will be resolved and will be done at the date set for the examination of the second part and the theory test.

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

Practices

Group evaluation:

Presentation of the results obtained during the practices and resolution of the proposed questionnaire. Attitude and behavior during the laboratory will also be taken into account.

Attendance to laboratory practices is mandatory. Only group changes will be accepted in an exceptional way and always with documentary justification. In the event of justified assistance to any of the practical sessions and noticing an option to perform it in a group other than the one assigned, this session will not be considered in the calculation of the practice note.

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

Qualifications

The three sections are inseparable, so that the student must participate, and be evaluated, in all of them in order to pass the subject. The final qualification is calculated according to the parameters that appear in the table that is presented below, so that the theory section accounts for 65% of the overall mark, the section of problems 20% and that of practices the 15 % remaining. In order to pass the subject it is essential that you have obtained a mark equal to or greater than 4.0 ineach of the partial examinations of theory. Once this

requirement has been met, the subject will be considered surpassed when the final grade is equal to or greater than 50 on a maximum of 100.

All assessable oral or written participation in English, except the final joint test, will have a maximum multiplier factor of 1.2 and a minimum of 1.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Delivery of dossiers / practical sessions questionnaires	15%	1	0.04	5, 11, 16, 26
Delivery of self-learning exercises	5%	1	0.04	1, 2, 25, 24, 3, 5, 8, 10, 7, 6, 9, 14, 13, 12, 11, 15, 16, 17, 18, 19, 20, 21, 22, 26, 4
Delivery of solved problems and in class resolution of exercicies	15%	1	0.04	23, 1, 2, 25, 24, 5, 8, 10, 7, 6, 9, 15, 16, 19, 20, 22, 4
Mixed partial tests: multiple answer/short questions	15%	1.5	0.06	1, 2, 25, 24, 5, 8, 10, 7, 6, 9, 15, 16, 19, 20, 22, 4
Partial test exams	45%	3	0.12	1, 2, 25, 24, 5, 8, 10, 7, 6, 9, 11, 15, 16, 19, 20, 22, 4
Problems examination	5%	0.5	0.02	1, 2, 25, 24, 5, 8, 10, 7, 6, 9, 15, 16, 19, 20, 22, 4

Bibliography

Basic bibliografy (alphabetical order):

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Baynes JW, Dominiczak MH.

Medical Biochemistry, 5th Edition

Elsevier, 2018.

Última versió del llibre traduïda al castellà:

Baynes JW, Dominiczak MH.

Bioquímica Médica. 4ª Edición.

Editorial Elsevier, 2015

Recurs electrònic gratuït:

https://ebookcentral.proquest.com/lib/uab/detail.action?docID=3429739

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Berg JM, Tymocsko JL, Gatto GL, Stryer L.

Biochemistry. 8th Edition.

W.H. Freeman, 2015

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Última versió publicada:

Wilson K., Walker J.

Principles and techniques of practical Biochemistry, 8th Ed.

Cambridge University Press, 2018

EXERCICES

- 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