Universitat Autònoma de Barcelona

2017/2018

Biochemistry II

Code: 100876
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	FB	2	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

The classes of theory and problems will be in Catalan, but most of the graphic material and the bibliography will be in English or Spanish.

Prerequisites

There are no official prerequisites. However, it is assumed that the student has acquired the knowledge taught in previous courses of the first year of the degree of Biochemistry, in particular the contents of those of Organic Chemistry of Biochemical Processes, Microbiology, Histology, Cell Biology and in particular of Biochemistry I, such as those referring to principles of bioenergetics, enzymology, structure and function of carbohydrates, lipids, proteins and nucleic acids.

Objectives and Contextualisation

The subject Biochemistry II constitutes the second part of the subject "Biochemistry" of the Degree in Biochemistry. Biochemistry II covers the basic aspects of the metabolic pathways, the associated energy changes, their physiological significance, their interconnections and response to biological signals from a basic and general point of view, as corresponds to a second year subject. The general objective of the subject is to provide the students the basics of the metabolic aspects necessary for the follow-up of many subjects of the Degree in Biochemistry.

Specific objectives:

- Describe the general mechanisms through which living beings obtain and transform the energy of the environment.

- To know the main molecular mechanisms for the transduction of biological signals.

- Describe the transporters of metabolites through the membranes.

- Describe the central pathways of the metabolism of carbohydrates, lipids, amino acids and nucleotides.

- Know the components of the electronic transport chains, their coupling with oxidative phosphorylation or photophosphorylation, and how metabolic energy is obtained.

- Give an overview of the interconnections between the metabolic pathways, as well as the mechanisms that regulate them in a coordinated way and their alterations in various physiopathological situations.

- Know how to apply the acquired knowledge to solve qualitative and quantitative problems.

- Know how to handle the bibliography and apply the information resources for the search of information.

Skills

- Collaborate with other work colleagues.
- Describe intercellular and intracellular communication systems that regulate the proliferation, differentiation, development and function of animal and plant tissues and organs.
- Describe metabolic routes, their interconnections and their physiological significance, and also understand the mechanisms that regulate their activity to satisfy physiological needs.
- Interpret experimental results and identify consistent and inconsistent elements.
- Manage bibliographies and interpret the information in the main biological databases, and also know how to use basic ICT tools.
- Manage information and the organisation and planning of work.
- Read specialised texts both in English and ones own language.
- Use ICT for communication, information searching, data processing and calculations.

Learning outcomes

1. Collaborate with other work colleagues.
2. Correctly use the terminology of biochemistry and its text and reference books.
3. Describe correctly the structural and thermodynamic bases of cell bioenergetics and transport across membranes.
4. Describe the metabolism of glucids, lipids, amino acids and nucleotides.
5. Identify the components of the electronic transport chain, its coupling with oxidative phosphorylation and the generation of metabolic energy.
6. Identify the principal metabolic pathways and their mechanisms of control and integration.
7. Interpret experimental results and identify consistent and inconsistent elements.
8. Manage information and the organisation and planning of work.
9. Read specialised texts both in English and ones own language.
10. Understand the molecular mechanisms responsible for signal transduction.
11. Use ICT for communication, information searching, data processing and calculations.

Content

Theory

Topic 1. Basics of metabolism.

Concept of metabolism and metabolic pathway. Experimental methods for the study of metabolism. Phases of metabolism Energy transfers in metabolism. Control and compartmentalisation of metabolic pathways.

Topic 2. Biosignalling

Hormones, neurotransmitters, growth factors and other primary messengers. Membrane and intracellular receptors. Molecular mechanisms of signal transduction. Integration of effects at the cytoplasmic and nuclear level.

Topic 3. Glucose metabolism.

Glucose transporters. Degradation of glucose: glycolysis. Fermentations. Gluconeogenesis. The Cori's cycle. Regulation of glycolysis and gluconeogenesis. The pentose phosphate pathway.

Topic 4. Metabolism of glycogen and coordination in the control of carbohydrate metabolism.

Synthesis and degradation of glycogen. Coordination in the control of the metabolism of glucose and glycogen. Metabolism of other carbohydrates and other pathways of glucose metabolism.

Topic 5. Central routes of oxidative metabolism.

Metabolic pathways leading to the formation of acetyl-CoA. The pyruvate dehydrogenase complex. The citric acid cycle. Energy performance and regulation. Anaplerotic reactions. Amphibolic nature of the cycle: connections with biosynthetic pathways. The glyoxylate cycle.

Topic 6. Electronic transport, oxidative phosphorylation and photophosphorylation.

Mitochondrial electron transport chain. Origin and use of reduced substrates. Chemiosmotic coupling: ATP synthase and oxidative phosphorylation. Mitochondrial transport systems. Regulation of oxidative phosphorylation. Energy balance of oxidative metabolism (example of glucose). Uncoupling proteins and thermogenesis. Photosynthesis: Electronic transport and photophosphorylation: Comparison with the respiratory chain and oxidative phosphorylation.

Topic 7. Metabolism of lipids.

Use of triacylglycerol in animals. Metabolism of lipoproteins. Oxidation of fatty acids. Ketogenesis. Biosynthesis of fatty acids: Activation of acetyl-CoA and fatty acid synthase. Elongation of carbon chain and unsaturation of fatty acids. Biosynthesis of triacylglycerols and phospholipids. Metabolism of cholesterol and its derivatives.

Topic 8. Metabolism of nitrogen containing compounds: Metabolism of amino acids.

The nitrogen cycle. General characteristics of the synthesis and degradation of amino acids. Metabolic fate of the carbon skeleton of amino acids. Removal of ammonia and the urea cycle. Heme metabolism. Synthesis of amines of biological interest.

Topic 9. Metabolism of nitrogen containing compounds: Metabolism of nucleotides.

General characteristics of the metabolism of purine and pyrimidine nucleotides. Synthesis of deoxyribonucleotides: regulation of ribonucleotide reductase. Biomedical applications of analogues of glutamine and nucleotides.

Topic 10. Integration of metabolism.

Metabolic specialization of tissues. Metabolic characteristics of liver, muscle and adipose tissue. Metabolic adaptations to various physiopathological situations: Changes associated with the various nutritional states and exercise. Metabolic alterations in diabetes and obesity. Biotransformation and drug detoxification.

Problems

The problems classes will focus on some aspects of the theory program. The particular characteristics of the diverse parts of the theory program make the formulation of the problems concentrate on certain aspects, such as the enzymatic reactions (oxidation-reduction, transfer of chemical group, etc.) that constitute the various stages of metabolism, its regulation in response to

the activation of different signalling pathways and their relevance on different pathophysiological conditions. A dossier with the formulation of the problems will be delivered through the Virtual Campus in advance to the problems class where they must be dealt with.

Methodology

The subject of Biochemistry consists of theoretical classes, classes for resolution of practical cases and problems, submission of homework by the Virtual Campus and tutorials.

Theory classes:

The content of the theory program will be taught mainly by the teacher in the form of master classes. Presentations used in class by the teacher will be available to the students Virtual Campus of the subject in advance at the beginning of each of the topics of the course. These lectures will be the most important part of the theory section. It is recommended that students have the material published on the Virtual Campus in printed form so that they can follow the classes more comfortably. 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.

Problems classes:

It is intended that these classes serve to consolidate the contents previously worked in the theory classes and also to make the students familiarize with some of the experimental strategies used in biochemistry, with the interpretation of scientific data and the resolution of problems posed under real experimental situations.

For the problems classes the students will be divided into two groups (A and B) whose lists will be made public at the beginning of the year by the Degree Coordination. The student must consult which group they belong to and attend the classes corresponding to their group.

There will be 10 problems sessions for each group, which will be devoted to the resolution of practical cases and experimental problems related to the contents of the theory program. At the beginning of the semester a dossier with the formulation of the problems will be presented through the Virtual Campus and they will be resolved throughout the sessions.

In a limited number of sessions distributed throughout the semester, the teacher will expose the experimental and calculation principles necessary to work on the problems, explaining the guidelines for their resolution and, if necessary, by giving a complementary part of theory to facilitate their resolution. At the end of each session the teacher will indicate the problems that must be resolved by the next one. Students will work out problems out of the class hours, in work groups of three to four people which will be organized at the beginning of the semester and kept throughout the classes of problems. At the beginning of each session, each working group will bring the problems solved, which will be discussed and corrected with the participation of all students, so that each one of the problems will be solved by one of the different randomly selected work groups. Before starting the resolution of the problem, the chosen group will deliver the document with the resolution they propose (one delivery per group of three to four people). The teacher will ensure that all groups have the opportunity to publicly explain their problem-solving proposals throughout the semester. As indicated in the evaluation section, the public resolution of the problems will be taken into account in the final grade.

Submission of homework by the Virtual Campus:

Periodically (before each of the two partial tests of theory) a set of questions will be proposed through the Virtual Campus that students will have to solve before a specific date.

The student will send the answers to the teacher using the file delivery tool of the Virtual Campus. The file must be in pdf format, and cannot exceed the maximum file size allowed by the platform. It should be remembered that this application does not allow the delivery of files beyond the established deadline.

Tutorials:

Individual tutorials will be carried out at the request of the students. In the event that the number of applications was extremely high, especially in the face of partial examinations, a classroom tutorial could be held before each partial of theory (two in total), that would be announced through the Virtual Campus in due time. The objective of these sessions will be to solve doubts, review basic concepts and guide on the sources of information to consult. These sessions will neither be used to expose new topics nor to advance in the theory program but they will be sessions of debate and discussion.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Problems classes	10	0.4	11, 1, 10, 3, 4, 8, 5, 6, 7, 9, 2
Theory classes	35	1.4	10, 3, 4, 5, 6, 7, 9, 2
Tutorials	6	0.24	10, 3, 4, 5, 6, 7, 2
Type: Supervised			
Submission of homework by the Virtual Campus	12	0.48	11, 10, 3, 4, 8, 5, 6, 7, 9, 2
Type: Autonomous			
Study - autonomous work	72	2.88	

Evaluation

This subject will be evaluated by continuous assessment. The objective of the continuous assessment is to encourage the students' effort throughout the course, allowing them to evaluate their degree of follow-up and understanding of the subject.

Theory (70% of the overall grade)

Individual assessment through:

Two partial exams with test questions, which will be eliminatory if their qualification is equal to or greater than 4 (out of 10). The weight of each partial exam will be 35% of the overall grade.

A final exam with test questions corresponding to the first and second partials. Those students who have not been evaluated as well as those who have obtained a score lower than 4.0 (out of 10) in the previous examination of one or both of the partials will have to perform the examination of the corresponding partial (s) (first partial, second partial or both).

On the occasion of the final exam it will be possible to take the examination to improve the score of one or both partials. In this case, it is understood that the previous qualification is waived and the qualification obtained in the second test will be considered as the qualification of the partial.

The total weight of the theory evaluation will be 70% of the overall grade.

Evaluation through Virtual Campus: (10% of the overall grade)

Periodically (2 times during the course), a set of questions will be proposed that will have to be resolved before a specific date. The student will send the answers to the teacher using the file delivery tool of the Virtual Campus. The delivery will be individual and the weight of each delivery will be 5% of the global mark.

The total weight of the evaluation by virtual Campus will be 10% of the overall grade.

Problems (20% of the overall grade)

1-Individual assessment:

There will be an exam where problems related to those dealt with in problems classes will have to be resolved. This test will be carried out shortly after the problems classes are finished. The weight of this test will be 15% of the overall grade.

On the day of the final theory test, those students who have not obtained a mark equal to or greater than 4.0 (out of 10) in the test of problems will have to take another exam on the problems.

The weight of individual problem assessment will be 15% of the overall grade.

2- Team-work assessment:

In the course of the classes of problems it will be necessary to work in a team to resolve the problems, which will be exposed in class and evaluated. This activity will be done in groups of 3-4 students and the weight of the test will be 5% of the overall grade.

The weight of the evaluation of team problems will be 5% of the overall grade.

The total weight of the evaluation of problems will be 20% of the overall grade.

In all cases the acquisition of written communication skills will be taken into account in addition to the knowledge.

The three sections (Theory, Problems and Homework submitted by Virtual Campus) are inseparable, so that the student must participate, and be evaluated, in all three in order to pass the subject.

To pass the subject, it is necessary to obtain a final global grade equal to or greater than 5.0 (out of 10). It will be considered that a student will obtain the non-appraising qualification when the evaluation of all the assessment activities carried out does not allow him/her to achieve the overall grade of 5 in the event that he/she had obtained the maximum grade in all of them.

Any student, who cannot attend an individual assessment test any justified reason (such as illness, death of a first-degree relative or accident) and brings in the corresponding official documentation to the teacher or the Degree Coordinator, will be entitled to perform the missed test on another date.

Any student, who cannot participate in the continuous evaluation for any justified reason, can be evaluated (the same day as the final theoretical test is programmed) by means of a final exam consisting of test questions and resolution of problems. The maximum qualification that is

possible to achieve in this case is equivalent to 80% of the maximum, since it cannot cover the demands of some of the competences and learning results of the subject described above.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Evaluation of homework sent by the Virtual Campus	10%	6	0.24	11, 10, 3, 4, 8, 5, 6, 7, 9, 2
Evaluation of problems	20%	3	0.12	1, 10, 3, 4, 5, 6, 7, 2
Theory partial exams	70%	6	0.24	10, 3, 4, 5, 6, 7

Bibliography

Basic bibliography (alphabetical order)

Berg, J.M., Tymoczko, J.L., Gatto, G. J. i Stryer, L. "Biochemistry" (2015). 8ª ed. W.H. Freeman, New York. A translated edition is: "Bioquímica" (2013). 7ª ed. Ed. Reverté. Translated from the 7ª ed., 2012. Ed. W.H. Freeman. www.whfreeman.com/stryer

Horton, R., Moran, L., Scrimgeour, G., Perry, M. i Rawn, D. "Principios de Bioquímica" (2008). 4ª ed. Ed. Pearson. Traduït de la 4ª ed. anglesa de l'any 2006, Ed. Pearson. Also available is the 5th English edition: Moran, L., Horton, R., Scrimgeour, G., Perry, M., and Rawn, D. 'Principles of Biochemistry' (2013) Pearson International Edition.

McKee, T i McKee, J.R. "Bioquímica. Las bases moleculares de la vida" (2014) 5ª ed. McGraw-Hill-Interamericana, Madrid. Traduït de la 5ª ed. anglesa de l'any 2013, ed. Oxford University Press.

Nelson, D.L., Cox, M.M. "Lehninger-Principios de Bioquímica" (2014) 6th. ed. Ed. Omega. Translated from the 6ª ed., 2013. Also available is the7th English edition (2017). Ed. W.H. Freeman. www.whfreeman.com/lehninger/

Tymoczko, J.L., Berg, J.M., Stryer, L. "Bioquímica, Curso Básico" (2014) Ed. Reverté, Barcelona. Translated from "Biochemistry: A Short Course" 2nd ed.(2013) W.H. Freeman & Co. New York.

Voet D., Voet J.G. i Pratt C.W. "Fundamentos de Bioquímica. La vida a nivel molecular" (2016) 4ª ed. Ed. Médica Panamericana. Translated from the 4th English edition (2013).

Material available on the Virtual Campus.

Presentations used by the teacher in theory classes.

A dossier with the formulation of the problems to work in problems classes.