VNIVERSITAT DE VALÈNCIA

Course Guide
33046 Biochemistry

COURSE DATA

Data Subject	
Code	33046
Name	Biochemistry
Cycle	Grade
ECTS Credits	10.0
Academic year	2018 - 2019

Study (s)

Degree	Center	Acad. year	Period
1100 - Degree in Biology	Faculty of Biological Sciences	2	Annual

Subject-matter

Degree	Subject-matter	Character
1100 - Degree in Biology	7 - Molecular and genetic basis of living beings	Obligatory

Coordination

Name	Department
LOPEZ RODAS, GERARDO	30 - Biochemistry and Molecular Biology
PAMBLANCO RODRIGUEZ, MARIA MERCE	30 - Biochemistry and Molecular Biology

SUMMARY

The subject of "Biochemistry" is included within the field of "Molecular and Genetic basis of living organism", which is compulsory in the degree in Biology. This course has 26 credits ECTS offered in the second year of the career, through two annual courses: "Biochemistry" (10 ECTS) and "Genetics" (10 ECTS), and a four-month course on "Molecular Methods in Biology" (6 ECTS).
The main objective of the subject of "Biochemistry" is to provide to the students with basic knowledge about the structure and function of biomacromolecules, about the different forms of the energy used by living organisms, and about the central metabolism and its regulation studied from an integrated point of view.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

1100 - Degree in Biology

- Skills in analysis and synthesis.
- Capacidad de resolución de problemas.
- Capacidad de razonamiento crítico.
- Capacidad de aprendizaje autónomo.
- Capacidad de comunicación oral y escrita.
- Capacidad de manejar el inglés como vehículo de expresión científica.
- Capacidad de utilizar las nuevas tecnologías de información y comunicación.
- Comprender el método científico.
- Capacidad de trabajar en equipo.
- Saber hacer análisis de datos científicos.
- Capacidad de búsqueda de información y análisis crítico de textos científicos.
- Conocer los mecanismos de replicación, transcripción, traducción y modificación del material genético.
- Conocer la estructura y función de las biomoléculas.
- Conocer las rutas metabólicas y su regulación.
- Conocer los mecanismos de señalización celular.
- Conocer los procesos biológicos de obtención y transformación de energía.
- Conocer los fundamentos de la catálisis enzimática y su regulación.
- Capacidad para trabajar correctamente en los laboratorios de Bioquímica, Genética y Biología Molecular, incluyendo seguridad, manipulación, eliminación de residuos y registro anotado de actividades.
- Capacidad para utilizar la instrumentación básica en los laboratorios de Bioquímica, Genética, Biología Molecular y Celular.
- Tener una visión integrada de las técnicas y métodos utilizados por la Bioquímica, Genética y Biología Molecular.

- Capacidad para diseñar experimentos y aproximaciones multidisciplinares para la resolución de problemas concretos.
- Capacidad para presentar, discutir y extraer conclusiones de los resultados de los experimentos científicos.

LEARNING OUTCOMES

- To gain robustness in the knowledge of basic biochemical.
- To learn the structure and the function of the biomolecules.
- To understand the mechanisms of replication, transcription and translation of the hereditary material.
- To understand the biological processes of the production of energy.
- To learn the central metabolic pathways and their regulation.
- To acquire the ability to solve problems and questions by applying the knowledge.
- To become familiar with the experimental work and basic laboratory techniques.
- To acquire the ability to follow basic protocols and to interpret the experimental data.
- To acquire the ability to understand and analyze scientific texts.
- To be able to use correctly the language of biochemistry.
- To acquire the ability to analyze, synthesize and develop critical assessment.
- To use oral and written scientific language.
- To acquire the ability of dissemination of the scientific knowledge.
- To be able to work in a team and be adapted to multidisciplinary contexts.
- To be able to prepare, show and defence their work to an audience.
- To study autonomously.
- To know and apply the scientific method.

DESCRIPTION OF CONTENTS

1. Introduction

Item 1. Introduction. Biochemistry and its relationship to other sciences. Chemical composition and characteristics of living matter. Structure and properties of water. The weak interactions in aqueous media. (1 h)
(Parentheses indicate the total hours of lectures)

2. Structure and function of proteins (Block 1)

Item 2: Structure of the proteins. Aminoacids. The peptide bond and the primary structure. Secondary structure. Tertiary structure and quaternary structure: Domains. Fibrous proteins and globular proteins. Folding and denaturizing of proteins. (4 h)
Item 3: Dynamics of proteins. Functional classification of proteins. Binding of ligands. Cooperativity and allosterism. Study of the myoglobin and the hemoglobin. (3 h)

3. Enzymology (Block 2)

Item 4: Chemical nature of enzymes. Active center. Enzyme specificity. Classification and nomenclature of enzymes. Enzymatic catalysis. Cofactors. (1 h).
Item 5: Enzyme kinetics. Model of Michaelis-Menten. The effect of pH and temperature. Enzyme inhibition. (2 h).
Item 6: Molecular mechanisms of enzymatic regulation. Regulation of enzyme concentration. Allosterism. Covalent modification of enzymes. Amplification of signals. (2 h).

4. Structure and function of nucleic acids (Block 3)

Item 7: Structure and organization of the nucleic acids. Informational metabolic processes. Primary structure. Secondary structure: Model of Watson and Crick. High order structures; the circular and supercoiled DNA. Organization of the genomes and structure of the genes. (2 h).
Item 8: Molecular mechanisms of the genetic information flux. DNA polymerases; enzymology of elongation of the polynucleotide chain. Enzymology of RNA synthesis. Mechanism of transcription. The genetic code. The mechanism of translation. (4 h).
Item 9: Genomics and proteomics. Methods for the analysis of nucleic acids and proteins. Study of evolutionary relationships through the structure of biomacromolecules. (1 h)

5. Bioenergetics (Block 4)

Item 10: ATP-ADP system. Thermodynamics of life. Biochemistry of ATP. Coupling between endergonic and exergonic reactions. Energy sources and strategies for the generation of ATP. (1h)
Item 11: Biomembranes and transport. Composition, structure and properties of biological membranes. Thermodynamics of the transport across the membrane. Classification of transport systems. Chemiosmotic theory and ATP synthase. (2 h)
Item 12: The respiratory chain. Function of the respiratory chain. Thermodynamics of the redox reactions. Classes of electron carriers: structure, organization and process. Oxidative phosphorylation. Respiratory control. Inhibitors and uncouplers. (2.5 h)
Item 13: The photosynthetic chain. Function of the photosynthetic chain. Photosynthetic pigments. Photosystems. Organisation and process of the electron carriers. Photophosphorylation. (1.5 h)

6. Intermediary metabolism (Block 5)

Item 14: Overview of intermediary metabolism. Organization of the metabolism. Catabolism and anabolism. Characteristics of the metabolic pathways and their regulation. Steps of the degradation of carbohydrates, lipids and proteins. (1 h)
Item 15: The acetyl-CoA and the citric acid cycle. The citric acid cycle. Origin and destiny of the acetyl-CoA. The citric acid cycle: enzymatic steps. Regulation of the citric acid cycle. Amphibolic and anaplerotic character of the citric acid cycle. (1h)
Item 16: Metabolism of carbohydrates. Glycolysis: enzymatic steps and its regulation. Destinations of the pyruvate. Gluconeogenesis: enzymatic steps and its regulation. Coordinated regulation of glycolysis/ gluconeogenesis by hormones. The Cori cycle. The glyoxylate cycle. The glycogen metabolism and its regulation. The pathway of the pentose phosphates. The Calvin cycle: autotrophic CO2 fixation.

Photorespiration. (5 h)
Item 17: Metabolism of lipids. Digestion, absorption and transport of the triglycerides and the lipoproteins. Mobilization of lipid storages. Degradation of fatty acids: beta-oxidation. Synthesis of fatty acids. Coordinated regulation of lipid metabolism. Synthesis and uses of ketone bodies. (3 h)
Item 18: Metabolism of the nitrogen-containing compounds. Oxidative degradation of amino acids. Nitrogen excretion. Nitrogen cycle in the biosphere. Nitrogen fixation. Biosynthesis of amino acids. Nucleotide metabolism. (2 h)
Item 19: Integration of metabolism. Overview of the metabolism. Metabolic patterns on tissues and organs. Hormonal control of the energy metabolism. Metabolic adaptations: fasting-feeding cycle, diabetes, exercise. (1 h)

7. Problems of Biochemistry

1. pH buffer solutions (3 h)
2. Enzyme kinetics (3 h)
3. Bioenergetics (3 h)

8. Laboratory practices

1. Preparation of buffer solutions: Checking the buffering capacity. Study of protein solubility as a function of the pH. Isoelectric point. (3 h)
2. Separation of proteins by ion exchange chromatography. Electrophoretic separation of proteins: Cellulose acetate and SDS-PAGE. (3 h)
3. Enzymatic activity assay of the alkaline phosphatase. Determination of kinetic parameters. Effect of an inhibitor on the kinetic parameters (3 h)
4. Preparation and electrophoretic analysis of genomic and plasmidic DNA (3 h)
5. Effect of the wavelength on the reducing capacity of the chloroplasts (3 h)
6. Metabolism of carbohydrates. Alcoholic fermentation. Quantification of liver glycogen (3 h)

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	67,00	100
Laboratory practices	18,00	100
Classroom practices	9,00	100
Tutorials	6,00	100
Development of group work	10,00	0
Study and independent work	128,00	0
Readings supplementary material	12,00	0
TOTAL	**250,00**	

TEACHING METHODOLOGY

The development of the course is divided into:

Theory lectures and questions

40 classes of an hour length will be provided (with approximately 2 sessions per week), where will be used primarily the format of "*master lecture*". The professor will show the most relevant information of the subject using audiovisual media. The documents needed to follow the lectures will be published in the Aula Virtual.

There will be 10 sessions of one-hour length throughout the course (5 in each four-month period), intercalated with the lectures, usually at the end of each block of the program. These sessions will encourage to the student participation through the resolution of questions. Before any of the sessions, the professor may request some written question resolved. This activity will reveal how students assimilate concepts and, thus, to better evaluate the student work.

Sessions of problems

Nine sessions of one-hour length will be provided throughout the course: 6 sessions in the first four-month period and 3 in the second four-month period. The last session of each period will be used to solve a written test in the classroom. A list of problems with the results will be provided. In addition, at the Aula Virtual will be available explanations of theoretical knowledge to solve model problems as well as some solved examples. The professor may request the delivery of any of the problems solved.

Sessions of laboratory

The attendance is mandatory. There will be 6 sessions of 3 hours length (4 in the first four-month period and 2 in the second four-month period). The students will have before the session a notebook containing the script for the sessions, with a small theoretical introduction and a detailed protocol of the session. The students should prepare at home the session and to response to a brief questionnaire, provided before each session, that it must be submitted on the day of the session.

Supervised tutorials sessions

There will be 6 tutorial sessions (3 in each four-month period), with groups of 16 students where the professor will resolve questions about the content of the course (theory, problems and laboratory). These sessions could be also used to carry out evaluation activities.

Interdisciplinary project: Preparation and exposure of a seminar

The activity is mandatory, interdisciplinary and transversal, It is common to all subjects of the second course of the degree in Biology (Cellular and Tissular Biology, Developmental Biology, Biochemistry, Botany, Genetics, Methods in Molecular Biology, Processes and Mechanisms of Evolution, and Zoology). The activity consists in the preparation and presentation of a seminar by a working group (3 students). The theme of the seminar, linked to one of the participating subjects, will be decided by lotery from among those proposed by the teachers. Each group will have a tutor who will supervise the preparation

and presentation of work. The tutor will meet 4 times with the work group throughout the course. Each group will also have a co-tutor (among the professors of the course) to review the final work. The oral presentation will last 30 minutes and should involve to the 3 members of the group. The exhibition will be evaluated by the tutor and by the co-tutor. The attendance at the presentations is compulsory for all students. Details regarding this activity will be published in the Aula Virtual.

Alternatively to this activity, it can make other interdisciplinary activity of a project of educational innovation supported by the CAT.

Attendance to the conferences and other activities

The student must attend all conferences and other activities that will be programmed throughout the course. Subsequently, the students will submit a summary related to the subject.

Reading and summarize a general book

The student will read a science book that will be related with the subject of Biochemistry from those proposed by the professors. Subsequently, the students should submit a reading sheet model, available in Aula Virtual.

EVALUATION

Evaluation of the subject

The evaluation will be done along the course. It will combine the assessment resulting from direct contact with each student during lectures and tutorials sessions, with the appropriate resolution of writing questions and those proposed during lectures, with the work carried out by students and with examinations marks. To pass the course, it will be necessary to obtain an overall rating equal to or greater than 5 out of 10, having passed each of the parts: theory, questions and practices.The qualifications of questions, laboratory, interdisciplinary work, class participation, and reading and review of popular books will be added once past the contents of theory.

Evaluation of the theoretical lectures

The result of this evaluation will be 6,5 points of the final course score.

There will be a midterm exam, suitable to pass the material, after the first four-month period about the contents for the issues of introduction and blocks 1, 2 and, and a second exam at the end of second four-month period (containing subject of blocks 4 and 5). In this exam it may also undertake a review of the contents of the first partial. The exams will be past due with a score greater than or equal to 5 (of 10). It will also evaluate the student's participation in the resolution of questions as well as the discussion of these questions in classes and tutorials. The qualifications of the approved exams, or the whole theory, will be saved only until the second call.

Evaluation of the problems

The result of this evaluation corresponds with 1.0 point in the final course score. The last session of each term problems will be devoted to carrying out a partial qualifying round test. In the first four-month period the exam shall be conducted on the contents of "buffer pH Solutions" and "Enzymology", and in the second four-month period on "Bioenergetics." The problems will be considered approved if the course score earned in each of the two partial tests are equal or superior to 5 (of 10).

There will be a final test of problems, to be performed in conjunction with the examination of the theory, in which students will be examined for any party that has not been surpassed in the partial tests. The passing score on the problems will be saved until the second call.

Evaluation of the laboratory

This part will represent up to 1.5 points in the final course score. The laboratory sessions will be evaluated by two partial exams, the attitude and use in the laboratory and the correction of the previous questionnaire. In the first four-month period, the exam will be on practices 1 to 4. In the second, the practices 5 and 6. The laboratory practices are considered as passed when the marks of the two written tests are equal or superior to 5 (of 10).

There will be a final written exam for the laboratory sessions that will be done together with the theoretical exam, in which students will examine the parts not passed on partial exams. To pass the course it must be obtained a score of 5 out of 10 in this part. In case of approval the laboratory practices, but not the subject as a whole, the marks of practices will be saved for the year after.

Evaluation of the interdisciplinary project

The evaluation of the interdisciplinary project will involve 1.0 points from the overall subject. In the evaluation will participate the tutor and the co-tutor of the work. The evaluation will consider the contents and the oral presentation. The projects selected for presentation at the Congress of Biology will have an additional qualification corresponding to 10% of the mark of the activity. The mark of the interdisciplinary project will be saved for the next course.

If the interdisciplinary project is not executed, it will not be possible to pass the course connected with the work. For the subject of Biochemistry, if suspended for not having done this activity, the marks earned in the other parts of the course (theory, laboratory and practices) will be saved for the next year, provided they are approved. If interdisciplinary project is not done, and this is not related to Biochemistry, the final score will include the marks obtained in the other parts of the course and must be equal to or greater than 5.

Evaluation of the reading and summarize a general book and other activities

The activities will be evaluated with a maximum score of 0.5 points, which will be added to the score of the rest of the course.

Evaluation of the second call

It will follow the same evaluation criteria that have been exposed for the first call and it consist of a unique exam of theory (6,5 points), problems (1 point) and laboratory (1,5 points) of the subject. The interdisciplinary project is not done more than once during the course.

REFERENCES

Basic

- Peretó, J., Sendra, R., Pamblanco, M. y Bañó, C. Fonaments de bioquimica. Servei de Publicacions de la Universitat de València, 5ª ed., 2005 (traducción al castellano, 2007).
- Stryer, L., Berg, J.M. y Tymoczko, J.L. Bioquímica Curso básico Ed. Reverté, 2014. (3ª ed., inglés, 2016)
- Stryer, L., Berg, J.M. y Tymoczko, J.L. Bioquímica con aplicaciones clínicas Ed. Reverté, 7ª ed., 2013 (traducción de la edición inglesa, 2012).
- Stryer, L., Berg, J.M. y Tymoczko, J.L. Bioquímica. Ed. Reverté, 6ª ed., 2007 (català). (8ª ed., inglés, 2015)
- Nelson, D.L. y Cox, M.M. Lehninger. Principios de Bioquímica. Ed. Omega, 6ª ed., 2014. (6ª ed., inglés, 2013).
- McKee, T. y McKee, J.R. Bioquímica. Las Bases Moleculares de la Vida. MacGraw Hill Interamericana Editores, 5ª ed., 2014.

Additional

- Alberts, B. y colaboradores. Biología Molecular de la Célula. Ediciones Omega, 5ª ed., 2010 (6ª ed., inglés, 2014).
- Mathews, C.K., Van Holde, K.E., Ahern K.G. y Anthony-Cahill, S.J. Bioquímica. Ed. Pearson, 4ª ed., 2013.
- Voet, D. Voet, J.G., y Pratt, Ch.W. Fundamentos de Bioquímica: La vida a nivel molecular. Ed. Panamericana, 2ª ed., 2007 (4ª ed., inglés, 2013).