Universidad Rey Juan Carlos

TEACHING GUIDE

Biochemistry and Molecular Biology

GRADO EN INGENIERÍA BIOMÉDICA (INGLÉS) (1º y 2º curso) (2384)

ACADEMIC YEAR 2026-27

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I.-Subject Identification	
Type	OBLIGATORIA
Teaching period	1 course, 2Q semester
Nº of credits	6
Language in wich the subject is taught	English

II.-Presentation

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Presentation in english

Biochemistry and Molecular Biology are dynamic and rapidly growing disciplines that study the structure, organization and function of living organisms at the molecular level. They address such questions as the chemical and three-dimensional structure of biological molecules; the types and levels of molecular organization (how biological molecules interact each other to give rise to organized supramolecular structures, cells, multicellular tissues, and organisms); how their activities are coordinated; how cells synthesize and degrade biomolecules; how cells preserve and use energy; the mechanisms of cellular signaling and metabolic integration; how genetic information is stored, transmitted and expressed; or how genetic material is manipulated using recombinant DNA technology.

Relevance of the subject within the degree: Biochemistry and Molecular Biology is a basic scientific field that provides general training to numerous biomedical careers. Thus, the student will acquire knowledge, including terms and concepts, that can be useful in other subjects of the degree.

Learning outcomes: the aim of the subject is to offer the student a global vision of the molecular mechanisms that govern the reactions that cells use for the maintenance of their vital functions. Special emphasis will be placed on the study of the structure and function of proteins and enzymatic action, as well as on supramolecular organization by studying the structure, function and transport phenomena through biological membranes, cell signaling and signal transduction. A description of the main metabolic pathways that allow the assimilation and use of nutrients and the fundamental aspects of metabolic regulation will also be presented, which together allow to optimally adapt energy production to the needs of the organism. On the other hand, the main processes involved in the expression of the genetic message will be studied: replication, transcription and translation, highlighting the great development of the field at present, due to the implementation of new technologies, in particular genetic engineering and bioinformatics. Students will also be introduced to the study of omic sciences, different disciplines that are emerging as a result of important technological advances in recent years in the field of molecular biology and that seek an integral knowledge of the area to which they are linked, and whose information will allow understanding in the future the complex network of molecules and biological processes involved in a biological process or disease.

It is pretended for the student to acquire, on the one hand, a molecular knowledge of the fundamental biological processes, through the study of the structure, properties and organization of biomolecules, and of the metabolic transformations that allow living beings to carry out their biological functions. On the other hand, the student will learn the latest research techniques used for the study of these biochemical and molecular processes, all focused on deciphering the biological nature of living organisms to solve global needs related to health.

Recommended knowledge background: The student should have basic knowledge of Mathematics, Chemistry and Biology. In addition, it is recommended that the student has basic knowledge of the English language that allows him/her to read and understand scientific texts. Prior to the class, whether theoretical or practical, the student will be provided with appropriate materials and bibliography for the class. These materials will be used by the student for the preparation of the subject and the related seminars. In these seminars it corresponds to the student to have a leading role, in group or individually, solving questions, numerical problems or practical assumptions that the professor will raise. An active role of the student is recommended in order to achieve the formative objectives of the subject.

Disclaimer: The information given in this guide is orientative and flexible. Depending on the progress of the course and unforeseen events, it could suffer alterations that would be properly announced.

Academic behaviour: Link to the academic conduct policy:
https://www.urjc.es/internacional/181-normativa-propia

Student services:
https://urjc.atlassian.net/wiki/spaces/Home/overview?mode=global.

Indications about the functioning of the subject addressed to students taking this course at the Alcorcón campus: The students only have the right to examination and to the resolution of any doubts that may arise.

III.-Learning outcomes

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CON05. Understand or acquire the principles of bioelectrical fundamentals, ana-tomy, physiology or pathophysiology needed to identify the most appropriate processing technolo-gies for a given problem in biomedical engineering.
CON11. Understand the principles of how an organism functions from the cellular level, through the tissue level, up to the biological system level.
CON12. Understand the functioning of the molecular bases of genetics and proteins, the concepts of microbiology, pharmacology, and proteomics, and their applications in biomedicine.
CON13. Understand the fundamental concepts of molecular biology that are involved in the struc-ture, organization, and transmission of genes in living organisms, and the basics of epigenetics and metagenetics.
CON20. Knowledge and understanding of the mathematics, computation and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. (EURACE 1.1)
HAB17. Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. (EU-RACE 2.1)

- Key for degrees not adapted to RD 822/21: **CB** - basic competences, **CG** - generic competences, **CE** - specific competences, **CT** - transversal competences.
- Key for degrees adapted to RD 822/21: **CON** - knowledge, **COM** - competences, **HAB** - skills.

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IV.-Contents

IV.A.-Syllabus

THEORY

MODULE I. BIOMOLECULES

Unit 01. "Biomolecules". Water as a fundamental biomolecule. Biomolecules as building blocks: carbohydrates, nucleic acids, amino acids and lipids. Classification, structure and biological functions. Plasma membrane and transport phenomena.

Unit 02. "Amino acids and peptides". Peptides and proteins. Peptide bond. Folding and structural organization levels of proteins. Enzymes. Relationship between structure and biological function: allosterism and cooperativity. Biochemical signaling: hormones, transduction mechanism and receptors.

MODULE II. BIOENERGETICS, METABOLISM AND ITS REGULATION

Unit 03. "Introduction to metabolism". Bioenergetics and thermodynamics of biochemical processes. Transfer of phosphoryl groups and ATP. Biological oxidation-reduction reactions.

Unit 04. "Carbohydrates metabolism". Glycolysis, anaerobic pathways of glucose utilization and pentose phosphate pathway. Gluconeogenesis. Glycogen metabolism.

Unit 05. "Oxidative metabolism". Mitochondria. Pyruvate oxidation and Krebs cycle. Electron transport chain. Oxidative phosphorylation. Energy yield. Respiratory control.

Unit 06. "Lipid metabolism". Fatty acid absorption and transport. Beta oxidation and biosynthesis. Formation and utilization of ketone bodies.

Unit 07. "Protein metabolism". Degradation and biosynthesis of amino acids. Protein turnover. Urea cycle.

Unit 08. "Metabolic integration and regulation". Overview of energy metabolism pathways. Metabolic profiles of the different organs. Metabolic interrelationships between the main organs that metabolize fuels. Central role of the liver. Nutrition/fasting metabolic changes. Hormonal control of energy metabolism.

MODULE III. EXPRESSION OF GENETIC INFORMATION

Unit 09. "Replication". Chromosomal structure and functional units of DNA: genes. Mechanisms of replication in prokaryotes and eukaryotes. Mutations: replication errors and mutagenic agents. Mechanisms of DNA repair and recombination. Replication of telomeres of eukaryotic chromosomes.

Unit 10. "Transcription". Types of transcribed RNA and RNA polymerases. Gene organization: monocistronic and polycistronic RNAs. Function of promoters. Mechanisms of transcription in prokaryotes and eukaryotes. Post-transcriptional modifications of eukaryotic pre-mRNA.

Unit 11. "Translation". Characteristics of the genetic code. Transfer RNA and ribosomes. Post-translational processing.

Unit 12. "Regulation of gene expression". Regulation of gene expression. Positive and negative regulation in bacterial operons. Regulation of gene expression in eukaryotes.

Unit 13. "Introduction to Genetic Engineering". Transgenic organisms and their applications. Genomics and proteomics concepts.

EXPERIMENTALITY.

1a.-THEORY SEMINARS

Seminar I. "Catalysis and regulation of enzymatic activity". Enzyme kinetics. Michaelis-Menten model. Determination of Vmax and Km parameters by double inverse representation. Coenzymes and cofactors of the enzymatic reaction. Effect of pH and temperature on enzyme catalytic activity. Enzyme inhibition: types and characteristics. Allosteric regulation and regulation by covalent modification. Other forms of regulation: proenzymes or zymogens. Isoenzymes.

Seminar II. “Bioinformatics”: Introduction to -omic sciences.

Seminar III. "Recombinant DNA technology”. Recombinant DNA technology. Restriction enzymes. DNA ligase. Cloning vectors: characteristics and types. Methods of nucleic acid analysis. Polymerase Chain Reaction (PCR). DNA sequencing. Production of recombinant proteins of therapeutic and industrial value.

1b.-PRACTICAL SEMINARS OF BIOINFORMATICS

Seminar I. Organization and analysis of the matrix data extracted from a RNA sequencing assay

Seminar II. Analysis of the differential gene expression of a transcriptomic assay and the involvement of the differentially expressed genes in biological pathways and their interactions.

2.-LAB PRACTICES.

Practice 1: Bacterial transformation with exogenous DNA.

Practice 2: Fractional protein precipitation: obtaining protein fractions and quantitative determination of proteins. **Practice 3:**

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Determination of the kinetic parameters Km and Vmax of the enzyme DOPA Oxidase for the substrate L-DOPA: 3.1. Preparation of the enzyme extract. 3.2. Measurement of enzyme activity. 3.3. Determination of the type of inhibition exerted by hydroxybenzoic acid (4-HBA) and the kmap and Vmaxap kinetic parameters in the presence of the inhibitor.

IV.B.-Training activities	
Type	**Title**
Practical sessions	Practical seminar of bioinformatics 1: Organization and analysis of the matrix data extracted from a RNA sequencing assay.
Experimental and/or technological laboratories	Lab 1.- Fractional precipitation of proteins and quantitative assessment.
Experimental and/or technological laboratories	Lab 2.- Enzyme kinetics.
Experimental and/or technological laboratories	Lab 3.- Bacterial transformation.
Other activities	Theory seminar I: Catalysis and regulation of enzyme activity,
Practical sessions	Practical seminar of bioinformatics 2: Pathways and proteins interaction analysis of a transcriptomic assay.
Group work	Academically Guided Works.
Other activities	Theory seminar II: Bioinformatics: introduction to Omic sciences.
Other activities	Theory seminar III: Recombinant DNA technology.
Theoretical sessions	Temario de la asignatura

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V.-Student workload	
Theoretical sessions	32
Resolution of exercises, problems, case studies, etc.	16
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	9
Tests and/or exams	3
Academic tutorials	40
Related activities: conferences, seminars, etc.	8
Preparation of theoretical sessions and self-study	38
Preparation of practical tasks, exercises, case studies, projects, etc.	10
Preparation for tests and/or exams	24
Total student workload	180

VI.-Methodology and academic programme

Type	Period	Content
Theoretical sessions	Week 1 to Week 5	Units 01 and 02, plus theory seminars I and II.
Theoretical sessions	Week 5 to Week 10	Units 03 to 08 (both included).
Theoretical sessions	Week 10 to Week 14	Units 09 to 13 (both included) plus Theorý seminar III.
Seminars	Week 4 to Week 4	Theory seminar I: Catalysis and regulation of enzymatic activity.
Seminars	Week 5 to Week 5	Theory seminar II: Bioinformatics: introduction to -omics sciences.
Seminars	Week 14 to Week 14	Theory seminar III: Recombinant DNA technology.
Experimental and/or technological laboratories	Week 9 to Week 10	Lab practices. Bacterial transformation with exogenous DNA, Fractional protein precipitation and Determination of the kinetic parameters Km and Vmax of the enzyme DOPA Oxidase for the substrate L-DOPA.

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Resolution of exercises, problems, case studies	Week 11 to Week 11	Practical seminar of Bioinformatics: 1) Organization and analysis of the matrix data extracted from a RNA sequencing assay; 2) Pathways and proteins interaction analysis of a transcriptomic assay
Tests and/or exams	Week 8 to Week 8	1st Theory partial exam (Units 1 to 6, both included, plus theory seminars I and II).
Tests and/or exams	Week 16 to Week 16	2nd Theory partial exam (Units 07 to 13, plus theory seminar III).
Tests and/or exams	Week 12 to Week 12	Experimentality exam (Practical seminars of Bioinformatics plus Lab practices).
Group work	Week 15 to Week 15	Group oral presentations
Academic tutorials	Week 1 to Week 15	Academic tutoring available in group or individual sessions, either in person or online via Microsoft Teams. Sessions are scheduled upon request from students or faculty.

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VII.-Assessment methods

The general assessment method is continuous as established in the *Regulation for the Assessment of Learning Outcomes* of Rey Juan Carlos University.
All the assessment systems established in the degree report must be employed, except for those that have a minimum weight of 0%, which can be used by professors in the academic years they consider relevant. Each assessment system may be applied through one or more assessment activities, consistent with the system. No assessment activity can exceed individually 60% of the overall grade for the subject.
The sum of non re-evaluable activities cannot exceed 40% of the overall grade for the subject and, in general, should not have an established minimum grade (except for practical activities in which, strictly speaking, the conditions of the ordinary call cannot be reproduced in the extraordinary call).
Those students who do not manage to pass the subject in the ordinary call, or do not attend this first call, may attend the extraordinary call only for failed re-evaluable assessment activities.
The distribution and characteristics of the assessment activities are described below.

VII.A.-Description and weight of the assessment activities

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VII.A.-Description and weight of the assessment activities

Procedure for the evaluation of the subject of BIOCHEMISTRY AND MOLECULAR BIOLOGY:

1.-Regular evaluation:

1.1.-Theory exams:

The theory exams evaluates knowledge and adquisition of related competences about the subject. Every theory partial exam evaluates one of the modules: module I, module II and module III. Together, the exams accounts for the ordinary call. Both exams consists of a multiple choice test on the theoretical contents reviewed at units of the subject related to the specific modules. For each question only one of the answer options is correct. Wrong answer subtracts score (the grading criteria for each exam will be set out in the exam instructions). The minimum mark to pass this exam and consider tasks as adquired is 5,00 (in an scale of 0,00 to 10,00). If any of the partial exams are qualified as fail, the student should attend the extraordinary call to re-evaluate the partial or partials that failed before. Then, if theory part of the subject is qualified as Fail, the subject will be qualified as Fail. The first theory partial exam call will be announced by the "Novedades" channel of the Virtual Classroom platform. The ordinary call will be published by Vice-Rectorate Office for Academic Planning. Both theory exams will be held on-site.

Remember that failing any theory part means that the theoretical part of subject will be failed.

1.2.- Experimentality exam - Lab practices and bioinformatics:

Exam corresponding to Experimentality (practical seminars of bioinformatics and lab practices) evaluation should be called around week 12 of the course, being this considered as the ordinary call for this part of the subject. Attendance and participation in all laboratory exercises (on-site) and bioinformatics seminars (on-site) is a mandatory requirement for passing the subject. Failure to attend will automatically result in a failing grade for the experimental section. Failing the experimental section will result in failing the entire subject, even if the theoretical section is passed. Both bioinformatics and lab practices will be assesed in the same exam. The exam consist of a multiple choice test and/or exercices that include concepts and experimental approaches treated in both practices and bioinformatics seminars. Considering the test-type exam, for each question only one of the answer options is correct, and wrong answer subtracts score (the grading criteria for each exam will be set out in the exam instructions). Exam should be held on-site.
The minimum mark to pass the exam and consider tasks as acquired is 5.00 (in an scale of 0,00 to 10,00). Once the experimentality is passed, its qualification will be preserved until passing the theoretical part. Thus, in the case of repeating the subject, qualification obtained at experimentality (lab practices and bioinformatics) will be taken in consideration and it will be unnecessary to attend again.
Remember that failing the experimental part means that the whole subject will be qualified as Fail.

1.3.- Oral presentations of grupal work:

Up to 10% of the final mark for the completion and presentation of an academic guided work . The work supporting the oral presentation will be performed by a group work (about 5 people), on a students-interest topic related with biochemical or molecular biology in Biomedical Engineering. At the end of the regular teaching period, they must present a video / PowerPoint recording of a maximum of 10 min. as a evidence of the work (everyone participates in the video/PP speech and on-site presentation). Two follow-up seminars will be held prior to delivery. The work will be considered as part of the continuous evaluation, and so there is no reevaluation if mark scores below 5,00.

Weighting in the final mark:

Theory: 1st partial exam: 24 %; 2nd partial exam: 24 % and 3rd partial exam: 24 %.
Experimentality: Lab practices & Bioinformatics (18 %), and oral presentation of grupal work (10%).

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ORDINARY CALL (summary chart)

Evaluation Systems (1)	Evaluation activity	Nature	Minimum mark	Weighting (2)	Type Modality (3)	Contents	Period
ES2	Theory written test	Individual	5	24 %	Reassessable Onsite	Written test related to theoretical contents of units 1 to 2 (both included) plus theory seminars I and II.	During the school period
ES5	Experimentality written test	Individual	5	18 %	Reassessable Onsite	Written test related to the practical contents of laboratory and practical seminars of bioinformatics.	Week 12
ES2	Theory written test	Individual	5	24 %	Reassessable Onsite	Written test related to theoretical contents of units 3 to 8 (both included)	During the school period
ES2	Theory written test	Individual	5	24 %	Reassessable Onsite	Written test related to theoretical contents of units 9 to 13 (both included) plus theory seminar III	Ordinary call
ES3	Oral presentation	Group	NO	10 %	Non reassessable Onsite	Academically guided, free-choice group work related to Biochemistry and Molecular Biology.	Week 15

1. Evaluation Systems (ES) indicated in the subject's file in the degree's Verification Report
2. Must add up to 100%.
3. Assessment activities can be completed online only for online degrees.

2.- Extraordinary evaluation exams (re-assessment; call of June):

If one or both of the activities (both theoretical and experimental) are not accomplished, re-assessment in a exam to be held in

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the extraordinary call is available. It has to be obtained estrictly a minimum mark of 5,00 to consider the re-assessed part of the subject as Pass. With a mark lower than 5,00 in any of the re-assessed parts, the subject qualification will be "Fail". Weighted average between theory and experimentality marks obtained if any of these are below 5,00 will NOT be considered. Exams will be held on-site.

3.- Exams review:

Students do have the right to review their exams. Review will be called after the publication of the provisional marks of the subject. After the review, the final marks will be published. All announcements and marks will be published at the Virtual Classroom platform.

4.-Anticipated call:

The student who has requested the anticipated call should contact the professor in charge of the subject as soon as possible, in order to be provided by the necessary information and/or material for the evaluation, which will be similar to that followed by the rest of the students enrolled in the subject.

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VII.B. Assessment of students with academic exemption from class attendance

Having Academic Exemption from Class Attendance (DAAC) does not imply that students are automatically exempt from participating in the continuous assessment activities or in the training activities of compulsory attendance as established in the teaching guide. Once the exemption has been granted, students must contact the subject's teaching staff, who will propose the adaptations he/she may consider relevant, as long as they guarantee the acquisition and adequate assessment of the learning goals established. Students must maintain adequate communication with the teaching staff so that they may provide information on the dates for training and assessment activities, if these are not established in the programme and available for students at the time of achieving the exemption.

Subject with possibility of academic exemption: Yes.

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VII.C. Review of assessment activities

In accordance with the Regulation for the Assessment of Learning Outcomes of Rey Juan Carlos University.

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VII.D.-Students with a disability or special educational needs

In order to guarantee equal opportunities, non-discrimination, universal accessibility and academic success, students with disabilities or especial education needs may request curricular adaptations to follow their studies. These adaptations will be provided by the Unit of Attention to People with Disabilities of Rey Juan Carlos University, in accordance with the regulation which regulates the service for the Attention of People with Disabilities at the University. This Unit will issue a report for curricular adaptations, so that students with disabilities or special education needs must contact the service (at e-mail discapacidad.programa@urjc.es) in order to provide relevant information for different educational alternatives.

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VII.E.-Academic behaviour, academic integrity and honesty

Rey Juan Carlos University is fully committed to the highest standards of academic integrity and honesty, so studying at the URJC means assuming and subscribing to the values of integrity and academic honesty set out in the University's Ethical Code. To support this process, the University has the Rey Juan Carlos University's Academic Conduct Regulation as well as different tools (anti-plagiarism, supervision...) that offer a collective guarantee for the full development of these essential values.

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Subject with possibility of academic exemption: Yes.

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VIII.-Teaching resources and materials
Basic bibliography
Biochemistry. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr, Lubert Stryer. (8th edition, 2015). 1120 pp. W.H. Freeman. ISBN-10: 1464126100. ISBN-13: 978-1464126109
Lehninger Principles of Biochemistry. David L. Nelson, Michael M. Cox. (6th edition, 2012). 1340 pp. Worth Publ Inc. ISBN-10: 1429234148. ISBN-13: 978-1429234146.
Biochemistry. Christopher K. Mathews, Kensal E. van Holde, Dean R. Appling. (4th Edition, 2012). 1368 pp. Pearson. ISBN-10: 0138004641. ISBN-13: 978-0138004644
Introduction to genetic analysis. Anthony J. F. Griffiths, Susan R. Wessler, Sean B. Carroll (11th edition, 2015). 896 pp. W.H. Freeman &Co. ISBN-13: 978-1-4641-0948-5.
Fundamentals of Biochemistry: Life at the Molecular Level. Donald Voet, Judith G. Voet, Charlotte W. Pratt (4th edition, 2012). 1077 pp. John Wiley &Sons Inc. ISBN-10: 1118129180. ISBN-13: 978-1118129180.
Genetics: A Conceptual Approach. Benjamin A. Pierce (5th edition, 2014). 864 pp. WH Freeman. ISBN-10: 146410946X. ISBN-13: 978-1464109461.
Concepts of genetics. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino (Student edition, 2014). 752 pp. Benjamin-Cummings Pub Co. ISBN-13: 978-0321948472
Consultation bibliography
Molecular Biology of the Cell. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff. (6th edition , 2014). 1464 pp. Garland Science. ISBN-13: 978-0815344322.
Molecular Cell Biology. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin (8th Edition, 2016). 1280 pp. W. H. Freeman. ISBN-10: 1464183392. ISBN-13: 978-1464183393.
WebGestalt 2024: faster gene set analysis and new support for metabolomics and multi-omics. Nucleic Acids Research, 2024, 52, W415–W421. https://doi.org/10.1093/nar/gkae456
Reactome pathway analysis: a high-performance in-memory approach. Fabregat et al. BMC Bioinformatics (2017) 18:142 DOI10.1186/s12859-017-1559-2
Kanehisa, M., Furumichi, M., Sato, Y., Matsuura, Y. and Ishiguro-Watanabe, M. KEGG: biological systems database as a model of the real world. Nucleic Acids Res. 53, D672-D677 (2025).

IX.-Professors	
Name and surname	ALMUDENA GARCÍA CARRASCO
E-mail address	almudena.gcarrasco@urjc.es
Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Profesor/a Ayudante Doctor/a
Academic degree	Doctor
Person responsible for the subject	No
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico

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Number of quinquennia	1
Number of sexennia	1
No. of positive evaluations by Docentia	1
Name and surname	MARÍA GALÁN ARROYO
E-mail address	maria.galana@urjc.es
Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Profesor/a Contratado/a Doctor/a
Academic degree	Doctor
Person responsible for the subject	Yes
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	3
Number of sexennia	3
No. of positive evaluations by Docentia	1
Name and surname	PATRICIA CORRALES CORDÓN
E-mail address	patricia.corrales@urjc.es
Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Titular de Universidad
Academic degree	Doctor
Person responsible for the subject	No
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	2
Number of sexennia	2
No. of positive evaluations by Docentia	3

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