Universidad Rey Juan Carlos

TEACHING GUIDE

TISSUE ENGINEERING

GRADO EN INGENIERÍA BIOMÉDICA (INGLÉS) (3º y 4º curso) (2374)

ACADEMIC YEAR 2026-27

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I.-Subject Identification	
Type	OPTATIVA
Teaching period	4 course, 2Q semester
Nº of credits	3
Language in wich the subject is taught	English

II.-Presentation

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Tissue Engineering is a multidisciplinary field of knowledge which uses a combination of cells, engineering, and material science methods, and suitable biochemical and physicochemical factors to sustain, improve or replace biological tissues.
Scientific advances in biomaterials, stem cells, growth and differentiation factors, and biomimetic environments have created unique opportunities to fabricate tissues in the laboratory from combinations of engineered extracellular matrices ("scaffolds"), cells, nutrients and biologically active molecules. The continued success of tissue engineering and the eventual development of true human replacement parts will grow from the convergence of physicians, cellular biologists, biomedical and material engineers' basic skills and research.
This course will offer the student basic principles and concepts in relation to cell and tissue engineering, the presentation of tools and techniques concerning genetic therapy, and practical applications of the different fields under study. Moreover, the regulatory framework and current legislation that encompasses all aspects of tissue engineering and regenerative medicine will be presented.
To accomplish this objective the subject is organised in different central themes that, with their thoroughly development along the semester, will allow the student to obtain the required scientific knowledge and skills.
Likewise, the student is expected to acquire independence, critical thinking, experience and expertise by bibliographical reading, experimental activities and preparation and oral presentation of a writing assignment from the different topics developed along the programme.

Previous knowledge: For attending this subject students should have basic knowledge of Physiology, Biochemistry and Molecular and Cellular Biology. In addition, it is recommended that the students have fluency on reading and understanding scientific texts.
The information given in this guide is illustrative and flexible. Depending on the progress of the course and unforeseen events, changes may occur (they would be properly communicated).

Academic conduct:
Non-ethic practices during seminars and theory and / or practical exams (reading of notes and books related to the subject, asking other students, asking by mobile access or by smartwach via internet, telephone inquiries via call, SMS or any other type, etc.) are ABSOLUTELY PROHIBITED. Its practices will be penalized by denying the access to the classroom and qualifying the exam as FAIL with a numerical mark of 0.00.
According to the Dictionary of the Spanish Royal Academy, plagiarism consists of "copying in a substantial way other people's works, giving them as own". The plagiarism detected in the individual work seminars, in the reports and presentations of the group work, and in the practice notebooks they will be punished by cancelling said work and qualifying it as FAIL with a numerical mark of 0.00. The application of these measures does not prevent or cancel the appropriate actions, including the opening of the corresponding sanctioning issue by the academic authorities if necessary, contained in the code of academic conduct.

Institutional rules of conduct:
https://www.urjc.es/images/Universidad/Presentacion/normativa/normativa%20convivencia%20universitaria.pdf

Audio-visual record of the classes:
Under exceptional circumstances classroom classes might be recorded with the purpose of being used as a support material for the students. For the audio-visual record of the development of the classroom classes in any format (recording of the class in audio, video or both, either in physical or electronic support) should be formally requested by the course delegate to the teaching staff of the subject prior authorization, under the provisions of the General Data Protection Regulation (https://rgpd.es).
Whether the recording of the telematic classes is the same as that of the face-to-face classes, these recordings cannot be used by the student more than for the purpose of complementing his notes. The teachers of this subject DECLINE ALL LIABILITY regarding the inappropriate use of the same. Given the dynamics of the master class, it is possible that the teacher unintentionally commits some error in the exposition, error of which WE DECLINE ALL RESPONSIBILITY, since there is the possibility for the student to detect and correct the aforementioned error by tutorials, consultation of the recommended bibliography, etc. In case the student transfers the audio-visual records to third parties by any method, its origin must be referenced and what is clarified in this paragraph must be adequately indicated. In case of not respecting these regulations, the teaching staff will be asked to intervene by the academic authorities of the U. Rey Juan Carlos to formalize the corresponding complaint, passing on the offender or the resulting offender sanctions derived from the fact.

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III.-Learning outcomes

CG01 . Analyze and synthesize problems related to biomedical engineering, solve them and communicate them efficiently.
CG03. Write, represent and interpret legal, technical and biomedical documentation in the field of bioengineering
CG05. Know the rules, regulations and legislation in force, and apply them in biomedical engineering projects.
CB2 . That students are able to apply their knowledge to their work or vocation in a professional manner and have the skills that are typically demonstrated through the preparation and defense of arguments and problem solving within their field of study.
CB3 . That students have the ability to gather and interpret relevant data (usually within their field of study) to express judgments that include a reflection on relevant topics related to social, scientific or ethical areas.
CB4 . That students are able to transmit information, ideas, problems and solutions to both specialized and non-specialized audience.
CE01 . Understand or acquire the principles of bioelectrical fundamentals, anatomy, physiology or pathophysiology needed to identify the most appropriate processing technologies for a given problem in biomedical engineering
CE12. Analyze and control discrete and continuous time dynamic biomedical systems, both linear and non-linear
CE15. Solve physical problems in biomedical engineering using knowledge of: kinematics, dynamics, electromagnetism, waves, fluids, bioelectricity and biomechanics.
CE17. Designing instruments for medical applications
CE18 .Use sensors, controllers and biomedical signal acquisition systems for the evaluation and design of biomedical devices and systems
CE30. Understand the of the molecular bases of genetics and proteins, the concepts of microbiology, pharmacology and proteomics and their applications in biomedicine.
CE32. Understand the fundamental concepts of molecular biology involved in the structure, organization and transmission of genes in living organisms, and the basis of epigenetics and metagenetics
CE33. Understand the biological response to the use of materials and their application in biomedicine

- 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

A. Theory classes content

Different methodologies will be used to develop the contents. Different methodological approaches (lecture-based classes, seminars, presentations, etc) together with varied didactic material like, audio-visual material and recommended readings, will be provided to the student. In order to achieve a better organization and to reinforce the teaching-learning process, the lecturer will specify the strategy to develop in each formative activity. Moreover, the student will find available the appropriate and necessary material including bibliographic references in advance through the virtual classroom.

Chapter I. History and Introduction to the Tissue Engineering

Unit 1. - General concepts of Tissue Engineering, Cellular and Genetic Therapy: Regenerative Medicine. Antecedents.

Chapter II. Tissue Structure

Unit 2. - Stem cells. Definition and characteristics. Types and origin. Determination and cellular differentiation.
Unit 3. - Tissues and organs Fundamentals. Composition and organization: cells and components of the extracellular matrix. Signalling and cell communication. Cell-to-cell and cell-to-substrate interactions.
Unit 4. - Renovations and Regeneration of the tissues. Tissue Engineering relevance.
Unit 5. - Cellular therapy and recent applications: use of stem cells, iPSCs and differentiated cells.
Unit 6. - Immune system response. Tissue biocompatibility. Tolerance and vascularization.

Chapter III.- Biofabrication techniques and medical applications

Unit 7. - Bioreactors. Scaffolding-dependent and independent methods. Types of scaffolding.
Unit 8. - Bioprinting technology: cells and organs printing.
Unit 9. - Tissue engineering of the vascular system. Tissue-engineered vascular grafts. Cardiac valves. Regeneration and
Unit 10. - Tissue engineering of the digestive system. Artificial structures: small intestine. Artificial liver. Spleen and Langerhans islets.
Unit 11. - Tissue engineering of the skeletal muscle system. Myoblast therapy. Tendon. Ligament. Articular cartilage. Bone.
Unit 12. - Tissue engineering of the central and peripheral nervous system. Brain and spinal implants. Nervous fibre regeneration.
Unit 13. - Tissue engineering of sensory organs: eyes and skin.

Chapter IV.- Genetic Edition and Genetic Therapy. Recombinant systems. Transgenic animal

Unit 14. - Introduction to Genetic Engineering: Genetics, genetic information and genes. Basic molecular tools in Genetic Engineering: vectors and host systems.
Unit 15. - Genetic Therapy. Principles and types of genetic therapies. Methods of genetic transference. Anti-sense therapy. CRISPR/Cas genetic edition technique. Applications.
Unit 16. - Genetically modified organisms (GMOs). Methodology to generate transgenic animals: retroviral vectors, microinjection of DNA, stem cells modification, Cre-loxP system. Chimeric animals. Applications of transgenic animals

Chapter V.- Bioethics and Legislation

Unit 17. - Regulatory framework. Regulations on animal use for scientific purposes and genetically modified organisms.
Unit 18. - Specific aspects of advanced genetic therapies and commercialization systems. Human genome edition. Data protection systems and digital rights management. Bioethics

A. Formative activities

Analysis of a cientific project in group

Group preparation of a scientific assignment, elaborated from the theory concepts explained in class. At the end of the semester students will perform the oral presentation of their work. All the information concerning to the elaboration of the assignment will be available in advance in the virtual classroom.

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Seminars
The main objective of this activity is to reinforce and expand the concepts presented in the lectures. All the information concerning to the topics and the speakers will be available in advance in the virtual classroom.

Seminar 1. - Basic principles of cellular and tissue cultures.
Seminar 2. - Cellular culture applications in tissue engineering.

Laboratory practice
Experimental practice is design to complete the theoretical explanations provided in the lecture-based classes and it will be organize to conduct the following practice:

Practice 1. - DNA manipulation. amplification, digestion, and electrophoresis as a tool for molecular diagnosis

IV.B.-Training activities

Type	Title
Theoretical sessions	Lecture-based classes. Development of the aforementioned units.
Lectures	Reading of the recommended bibliography.
Practical sessions	Experimental practice is designed to complete the theoretical explanations provided in the lecture-based classes and to promote the acquisition of instrumental and technical skills by the student. Attendance to the practices is compulsory. A script will be available for the student and the reading before carrying out the session is compulsory and object of evaluation during the exam. These documents specify in detail the experimental objectives and protocols to follow. A test will be used to evaluate the acquisition of the experimental knowledge but, answering some questionnaires and the handing in of the notebook at the end of the practices could be requested as well, in order to confirm the academic achievement during the practices.
Group work	Assignment in group. The activity consists on the research about a specific topic form the syllabus, handing in of the project and oral defence. It is a compulsory activity and the planning and presentation will take place along the semester.
Oral presentations	Oral presentation of the project.
Academic tutorials	Two partial exams about the syllabus explained in class and questionnaries about the seminars and lab parectice content.
Academic tutorials	Tutorials and guiding of the students in their research project when required.
Other activities	Theory Seminars. Attendance is compulsory and the main objective is to reinforce and expand the concepts presented in the lecture-based classes.

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V.-Student workload	
Theoretical sessions	18
Resolution of exercises, problems, case studies, etc.	8
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	3
Tests and/or exams	1
Academic tutorials	16
Related activities: conferences, seminars, etc.	8
Preparation of theoretical sessions and self-study	6
Preparation of practical tasks, exercises, case studies, projects, etc.	6
Preparation for tests and/or exams	24
Total student workload	90

VI.-Methodology and academic programme

Type	Period	Content
Theoretical sessions	Week 1 to Week 14	18 lecture-based participatory classes with a duration of 55 minutes each will be given. Audio-visual material will back up the theory content (specified in the Content section) and all the didactic material will be available for the student.
Seminars	Week 4 to Week 9	Attendance is compulsory and it will be controlled. The main objective of the theory seminars is to reinforce and expand the concepts explained in the lectures. A close to real research point of view of the topics will be presented. It is provided that the seminars are dynamic, with the participation of the students. All the information will be available for the student in advance through the virtual classroom. SEMINAR I (Aprox on week 5). Basic principles of cellular and tissue cultures. SEMINAR II (Aprox on week 9). Cellular culture applications in tissue engineering.

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Practical sessions	Week 14 to Week 14	Laboratory practice: DNA manipulation. amplification, digestion, and electrophoresis. The attendance to the practices is compulsory, following a control of it. All the required information relative to the practices, including the script and laboratory notebook, will be available for the student in advance through the virtual classroom.
Group work	Week 1 to Week 15	In group, the students will elaborate a scientific project focused on a topic related to the contents explained in the lecture-based classes. All the information concerning to the elaboration of the assignment will be available in advance in the virtual classroom.
Tests and/or exams	Week 11 to Week 11	Mid-term exam of the theory classes.
Academic tutorials	Week 1 to Week 15	Group and/or individual academic tutoring. In this tutorial sessions the student will explain the doubts related to the academic activities that could not be solved during the classes. Personal work, investigation and reasoning are expected for the students side prior the tutorial session. It should be scheduled by request of the students according to the availability of teaching staff. In addition, these tutorials will be used to guide students in the elaboration of the teamwork and oral presentations.
Other activities	Week 14 to Week 15	Oral presentation. The students will perform an oral presentation of the project that will take place along the last two weeks of the sessions scheduled for the subject. The preparation of the project and the oral presentation is compulsory for the student, as well as the attendance to all the oral sessions, which will be controlled. The information regarding the oral presentation will be available in advance in the virtual classroom.
Tests and/or exams	Week 16 to Week 16	2nd partial exam (theory classes + lab practices). Ordinary call examination.

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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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Procedure for the evaluation of the subject of TISSUE ENGINEERING:
Regular evaluation:

Theory exams:

The theory exams evaluates knowledge and acquisition of related tasks about the subject. Two theory exams are scheduled and both of them account for the ordinary call. The assessment consists of a multiple choice test on the theoretical contents reviewed at units of the subject related to the specific units. Each question will have four answer options, of which only one is correct. Wrong answer will have negative a score. The minimum mark to compensate the mark of the theory exam is 4.50 (in a scale of 0.00 to 10.00), althoug the final mark for the theory must be equal or over 5 to be considered in the global ponderation. These exams can be re-assessed. The first exam call will be announced by the "Novedades" channel of the Virtual Classroom platform. The ordinary call (for the second theory exam) will be published by Vice-Rectorate Office for Academic Planning.

Theory seminars and laboratory practice

Attendance at theoretical seminars and attendance at, and completion of, laboratory practical sessions are compulsory requirements. Attendance will be recorded either by means of a signature sheet or through the tool available on the Virtual Campus (attendance activity).

At the end of each seminar and laboratory practical session, students' acquired knowledge and skills will be assessed through a theoretical-practical questionnaire and/or exercises related to the concepts and experimental approaches covered in the corresponding session.

Questionnaires and exercises will not be eligible for reassessment. Non-attendance at any of the scheduled sessions will prevent the student from completing the corresponding assessment activity and from submitting the activities proposed for that session, resulting in the loss of the corresponding percentage of the final course mark. In cases where absence from a practical session is duly justified, the corresponding questionnaire may be completed during the ordinary examination period.

No minimum mark is required, and the assessment will be cumulative. This activity is formative and non-reassessable.

Evaluation of the scientific project and oral presentation

Preparation, submission and presentation of the research project, elaborated in group from different themes proposed along the development of the content, is compulsory to pass the subject. It will be an accumulative evaluation with no minimum mark. It is a non re-assessable activity.

Weighting in the final mark:

First (mid-term) theory exam……..……..30%
Second (ordinary call) theory exam ……..……..30%
Seminar 1 .....5%
Seminar 2 .....5%
Lab practice 10%
Preparation and oral presentation scientific assignment.....20%

Summary:

Activity		Type	Minimum Mark	Weighting (%)		Period	Content
THEORETICAL BLOCK	First (mid-term) exam	Reassessable in the extraordinary examination period	4,5 (over 5 together with the 2nd theory exam)	30%	60%	Weeks 1–9	Units 1–9.

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	Second (ordinary call) exam	Reassessable in the extraordinary examination period	4,5 (over 5 together with the 2nd theory exam)	30%		Weeks 10–16	Units 10–24.
PRACTICAL BLOCK	Seminar 1 questionnaire	Non-reassessable	No minimum mark is required	5%	20%	Approx. week 5	Contents from the seminar 1
	Seminar 2 questionnaire	Non-reassessable		5%		Approx. week 10	Contents from the seminar 2
	Laboratory practical session questionnaire	Non-reassessable		10%		Approx. week 14	Contents from the lab practice
TEAMWORK BLOCK	Preparation and oral presentation of a scientific assignment	Non-reassessable	No minimum mark is required	20%		Weeks 1–15	Scientific project based on the course contents.

Extraordinary evaluation exams (re-evaluation)

If one or both of the activities (both theoretical and experimental) are not accomplished, re-evaluation in an exam to be held in the extraordinary call is available. It has the same characteristics as the ordinary call and it has to be obtained strictly a minimum mark of 5.00 to consider the re-evaluated part of the subject passed. With a lower than 5.00 mark, the subject qualification will be "Fail". Compensation between theory and experimentality marks obtained will NOT be considered.

Students who fail to pass one or more parts of the subject corresponding to the theoretical examinations may reassess these components during the extraordinary examination period. The reassessment examination will have the same characteristics as those described for the ordinary assessment. NO compensation will be applied between the marks obtained in the theoretical and practical components.

Advanced evaluation:

It will be governed by Article 19 of the Evaluation Regulations of the Learning Results of the Rey Juan Carlos University, approved on June 12th, 2024. The method of evaluation used in this call will be the same as that described for this subject, except for the in-group preparation and oral presentation of a scientific assignment (30% of the final mark), which will be adjusted and adapted to ensure the evaluation of the learning outcomes planned for this activity.

Academic exemption

The academic exemption will only be applicable to the attendance to theory classes, with session attendance at 100% of lab practices,oral presentations and theory seminars.

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.

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.

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 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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VIII.-Teaching resources and materials
Basic bibliography
• Histology. A text and atlas with correlated cell and molecular biology. Ross MH, Pawlina W. (6 ed, 2010), Lippincott Williams and Wilkins. ISBN:1451101503 • Histología. texto y Atlas color con Biología Celular y Molecular.7a ed. Ross, M.H.; Pawlina. Editorial Wolters Kluwer (2016). ISBN: 978-8416004966 • Histology and cell biology. An introduction to pathology. Kierszenbaum AL, Tres LL. (5 ed, 2019), Elsevier. ISBN: 978-0323683784 • Kwon SG, Kwon YW, Lee TW, Park G, Kim JH. Recent advances in stem cell therapeutics and tissue engineering strategies. Biomater Res. 19;22:36. (2018). https://doi.org/10.1186/s40824-018-0148-4 • Dakhore S, Nayer B, Hasegawa K. Human Pluripotent Stem Cell Culture: Current Status, Challenges, and Advancement. Stem Cells Int. 22; 2018:7396905. (2018) • Tissue Engineering for Artificial Organs: Regenerative Medicine, Smart Diagnostics and Personalized Medicine, 2 Volume Set Anwarul Hasan (Editor) ISBN: 978-3-527-33863-4 • 3D Cell Culture Fundamentals and Applications in Tissue Engineering and Regenerative Medicine. By Ranjna C. Dutta, Aroop K. Dutta. ISBN: 9789814774536 • 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine. 2015. Lijie Grace Zhang, John P. Fisher and Kam W. Leong. ISBN: 9780128005477. • Biomaterials and Stem Cells in Regenerative Medicine. Murugan Ramalingam, Seeram Ramakrishna, Serena Best. ISBN: 978-1-4398-7925-2. • Stem Cells, Tissue Engineering and Regenerative Medicine. David Warburton. Worlds Scientific. ISBN: 9789814612777. https://doi.org/10.1142/9212 • Tissue Engineering. 2nd Edition. Clemens van Blitterswijk Jan De Boer. Elsevier. ISBN: 9780124201453 • Principles of Tissue Engineering. Robert Lanza, Robert Langer and Joseph P. Vacanti. Elsevier. ISBN: 978-0-12-398358-9. • Tissue Engineering. Clemens van Blitterswijk, Peter Thomsen, ... Jérôme Sohier ISBN: 978-0-12-370869-4. • Thompson & Thompson. Genética en Medicina. 8 edition Nussbaum, McInnes & Willard. Elsevier. ISBN 9788445826423. • Texto ilustrado e interactivo de Biología Molecular e Ingeniería Genética. Autor: Ángel Herráez. Editorial: Elsevier España, S.A. 2ª edición, 2012
Consultation bibliography

IX.-Professors	
Name and surname	JAVIER MARTÍNEZ USEROS
E-mail address	javier.useros@urjc.es
Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Profesor/a Permanente Laboral
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	1
Number of sexennia	2

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No. of positive evaluations by Docentia	1
Name and surname	LIDIA MARTÍNEZ FERNÁNDEZ DE SEVILLA
E-mail address	lidia.martinez@urjc.es
Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Profesor/a Permanente Laboral
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	1
Number of sexennia	1
No. of positive evaluations by Docentia	1
Name and surname	ROCÍO VILA BEDMAR
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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	2

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