Universidad Rey Juan Carlos

TEACHING GUIDE

BIOELECTRIC FUNDAMENTALS

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

ACADEMIC YEAR 2026-27

Q2803011B UNIVERSIDAD REY JUAN CARLOS
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I.-Subject Identification	
Type	OBLIGATORIA
Teaching period	4 course, 1Q semester
Nº of credits	3
Language in wich the subject is taught	English

II.-Presentation

Learning objectives: To introduce students to the basic techniques of Bioinformatics so that they are able to manage the information present in biological reference databases, in order to carry out basic analyses of proteins and nucleic acids sequences, to design in silico cloning, to build and inform phylogenetic trees, to predict three-dimensional protein structures, etc. Students will also be introduced to the study of basic techniques on structural and functional analysis of the genome and proteome (mainly focused on H. sapiens) and the relationship of these studies with the identification of the molecular causes of pathogenesis.

Learning outcomes: Students will work in a practical way with the basic techniques of Bioinformatics to be competent in the management of the information present in biological reference databases, in order to carry out basic analysis of protein and nucleic acid sequences, designing *in silico* cloning, to build and inform phylogenetics trees, to predict three-dimensional protein structures, etc. Students will also know the basic techniques of structural and functional analysis of the genome and proteome (mainly of *H. sapiens*) and the relationship of these studies with the identification of the molecular causes of pathogenesis.

Lecturing method:

1.- Theoretical lectures (17 lectures in the term, and an introduction to the subject by a review of the teaching guide).

2.- Experimental seminars (12 classes in the term; demonstrations and group work).

Evaluation formats: the evaluation (both ordinary and extraordinary) of the theoretical part will be carried out on-site, on a date and classroom to be determined by the Vice-Rector's Office for Academic Planning. Regardless of whether the assessment test for the theoretical part of the subject may be the ordinary call or the extraordinary call, it will have the same format: 30 multiple choice questions with four answer options each, where one answer is correct and three are not. The wrong answer will subtract score. Leaving the question blank does not subtract score (the grading criteria for the exam will be set out in the exam instructions). For the evaluation of the experimentality, each working group will present a notebook containing the resolution of all the assigned exercises, which will be graded. The notebook will be delivered in electronic format (Word or PDF, never paper) according to the format provided.

Previous knowledge:

1.- To have gained the competences of the subject of Biochemistry and Molecular Biology of the 2nd semester of the 1st year of the Degree.

2.- Languages: A minimum of B2 CEFR or Cambridge FCE is recommended; in other words, a sufficient level of technical English to read fluently and understand books, scientific articles and other scientific publications related to this field of study.

Academic behaviour, academic integrity and honesty: Non-ethic practices during seminars and theory and / or practical exams either if they are on-site or telematic (reading of notes and books related to the subject, asking other students or performing the exam on group, asking by mobile access or by smartwach via internet, telephone inquiries via call, SMS or any other type, etc.) are ABSOLUTELY FORBIDDEN. 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 canceling 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.

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III.-Learning outcomes

CG01 . Analyze and synthesize problems related to biomedical engineering, solve them and communicate them efficiently.
CG02. Use computational and experimental tools for the analysis and quantification of biomedical engineering problems
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.
CB5 . That students have developed the learning skills needed to undertake further studies with a considerable degree of autonomy.
CE31 . Use computational tools for DNA and RNA sequencing analysis, and microRNA and protein analysis

- 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

1.- Basic bioinformatics.

1.1.- Introduction and concepts: Biotechnology: definition and basic concepts. In sílico cloning. Bioinformatics: definition, professional profile, objectives, activities and applications.

1.2.- Hereditary diseases: pathological mutations. Classification: genomic, chromosomal and genetics. Type and pathogenic potential of gene mutations. Nomenclature. Molecular bases of Mendelian genetics.

1.3.- Biological sequence databases: File formats (Raw, FASTA, FASTAQ, SAM/BAM, GFF//GFF3GVF and VCD/BED). Design and basic concepts of databases. Examples of biological databases: GenBank, Entrez, UniProt, PDB, SIB, Genomic DDBB, PubMed, OMIM.

1.4.- Tools,alignments and algorithms. Types of tools. Basic concepts of alignment, similarity and distance. Simple, local, global and multiple alignments. Definition and graphical representation of algorithms. Main examples in bioinformatics: FASTA, BLAST, CLUSTAL.

1.5.- Applications, evolutive analysis and translational research. Definition and examples of applications. Molecular taxonomy: definition and concepts. Traslational research: definition and concepts.

2.- Genomics.

2.1.- Basic concepts. Definition of genomics. Chromatin and chromosome. Mapping. The Human Genome Proyect (HGP): description, experimental development and related techniques. Sequence assembling.

2.2.- Gene prediction. Basic concepts. Relevance of cis signals. Consensus sequences. Prediction made by comparison and ab initio methods. Applications. Assessment.

2.3.- Genomic browsers. Definition of genomic browser. Maps and gene identification in genomic servers: Genome Browser from UCSC and ENSEMBL from EBI.

2.4.- Microarray and massive sequencing analysis. DNA denaturation. Microarrays and genetic expression. Data: preprocessing, analysis and validation. Next Generation Sequencing (NGS). Metagenomics.

2.5.- DNA-protein interaction: ChIP-on-chip.

3.- Proteomics.

3.1.- Definition and lines of interest in biomedics.

3.2.- Techniques: two-dimentional electrophoresis and differential display, mass spectrometry, microarrays.

4.- Other topics from bioinformatics.

4.1.- Digital PCR.

4.2.- CRISPR/Cas9 probes design.

EXPERIMENTALITY: regular (practical exercices) and special seminars on bioinformatics.

1.- Regular seminars (practical exercices).

1.1.- Assignment of students to a work group, assignment of problem sequences to each work group and publication of each exercise statement.

1.2.- Introduction of the online computing resources to be used in the corresponding exercises.

1.3.- Performing of the corresponding exercices (1 to 4):

Exercise 1. Identification and analysis of a complementary DNA sequence using VecScreen, BLAST, GenBank, OMIM and NEBcutter2.

Exercise 2. Identification and characterisation of DNA mutations using ORF-Finder, Global Align (I) and Clustal Omega (I).

Exercise 3a: Characterisation of evolutionary relationships through sequence alignment using Global Align (II), BLAST (II) and Clustal Omega (II).

Exercise 3b: Prediction of gene-specific elements in genomic DNA using the Softberry suite.

Exercise 4: Characterisation of protein sequences using UniProt, Global Align (III), Clustal Omega (III), ProtParam, WolfPSort and SwissModel.

1.4.- Work group notebook delivery at the end of the teaching period.

2: Special seminars.

Special seminar 01: seminar conducted by an expert on a relevant topic related to the subject. Attending of the students is mandatory.

Special seminar 02: seminar conducted by an expert on a relevant topic related to the subject. Attending of the students is

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mandatory.

3.- Self-assessment.

Each team member is required to assess their own work and that of their colleagues using a template uploaded for this purpose to the 'Experimentality' section of the Virtual Classroom. Once the template has been completed, it must be sent to the lecturer in charge of the subject (Dr O. de Luis) via the Virtual Classroom's email tool. The content of the self-assessment is confidential (the teaching staff will not make it public). Failure to complete and/or submit this self-assessment will result in a fail for the experimentality module with a mark of 0.00.

IV.B.-Training activities

Type	Title
Theoretical sessions	Theory lectures (all the units of the subject).
Resolution of exercises, problems, case studies	Regular seminars: presentation of online computing resources and performing of the exercices.
Group work	Group work. Mandatory delivery of memory. General (CG1, CG2, CB2, CB5) and specific (CE31) competences of the subject will be evaluated.
Other activities	Self-assessment of the working group¿s activity. All members of the working group are required to submit the completed report.
Other activities	Special seminars: seminars presented by an expert on a relevant topic to the course. Attendance is mandatory.
Academic tutorials	Individual or group tutorials (maximum 3 people), either on-site or online (via Teams). Maximum session length: 1 hour. Tutorials must be booked in advance by email to arrange a date and time.
Test and/or exams	Theory exam. It includes all the units of the subject. General (CG1, CG2, CB2, CB5) and specific (CE31) competences of the subject will be evaluated.

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V.-Student workload	
Theoretical sessions	17
Resolution of exercises, problems, case studies, etc.	10
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	0
Tests and/or exams	3
Academic tutorials	20
Related activities: conferences, seminars, etc.	4
Preparation of theoretical sessions and self-study	8
Preparation of practical tasks, exercises, case studies, projects, etc.	12
Preparation for tests and/or exams	16
Total student workload	90

VI.-Methodology and academic programme		
Type	**Period**	**Content**
Theoretical sessions	Week 1 to Week 3	Theory lecture: unit 1.
Theoretical sessions	Week 5 to Week 6	Theory lecture: unit 2.
Theoretical sessions	Week 8 to Week 8	Theory lecture: unit 3 (1st part).
Theoretical sessions	Week 10 to Week 10	Theory lecture: unit 3 (2nd part).
Theoretical sessions	Week 12 to Week 12	Theory lecture: unit 4 (1st part),
Theoretical sessions	Week 14 to Week 14	Theory lecture: unit 4 (2nd part).
Resolution of exercises, problems, case studies	Week 4 to Week 4	Regular seminar 1: introduction to the online learning resources and completion of the exercises. Attendance is mandatory.
Resolution of exercises, problems, case studies	Week 7 to Week 7	Regular seminar 2: introduction to the online learning resources and completion of the exercises. Attendance is mandatory.
Resolution of exercises, problems, case studies	Week 9 to Week 9	Regular seminar 3: introduction to the online learning resources and completion of the exercises. Attendance is mandatory.

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Resolution of exercises, problems, case studies	Week 11 to Week 11	Regular seminar 4: introduction to the online learning resources and completion of the exercises. Attendance is mandatory.
Seminars	Week 13 to Week 13	Special seminar 01: seminar conducted by an expert on a relevant topic related to the subject. Attending of the students is mandatory.
Seminars	Week 15 to Week 15	Special seminar 02: seminar conducted by an expert on a relevant topic related to the subject. Attending of the students is mandatory.
Group work	Week 15 to Week 15	Each working group must submit their experimentality report, including the completed exercises, for assessment. Each group member must send their self-assessment to the lecturer in charge of the course. Both submissions are mandatory.
Tests and/or exams	Week 15 to Week 15	Theory exam (ordinary call). Theory exam (regular sitting). Covers all topics on the syllabus.

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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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1.-Assessed parts of the subject

The Bioinformatics and Biotechnology subject consists of the following parts: Theory and Experimentality (group work).

1.1.-The minimum mark to pass the theory exam and consider skills as adquired is 5,00 (in an scale of 0,00 to 10,00). IT IS AN ESSENTIAL REQUIREMENT to pass the theory with a mark of 5.00 or higher. Then, if theory part of the subject is qualified as Fail, whole subject will be qualified as Fail. Students that fail in the ordinary call should be able to re-assess theory in the extraordinary call. Once theory is passed, subject is passed only if average mark between theory and experimentality is 5,00 or higher (it is mandatory).

1.2.-Experimentality is NOT re-assessable and has no minimum mark to pass. In the final mark of the subject, the generic mark of Fail will be 4.00 and will indicate that the weighted average between both parts is not enough to pass. The qualification of "Not presented" in the subject will only be obtained when the student has not attended any of the evaluated tests of the subject, including the continuous evaluation and the ordinary and extraordinary calls.

2.-Weighting of the subject.

Theory: 60% Theory exam (test type). Contains questions covering all the theoretical content of the subject. Exam with 30 multiple choice test questions: four options, one is correct and three are not, the wrong answers score negative; blank answers do not substract any score (the grading criteria for the exam will be set out in the exam instructions). MINIMUM MARK: 5/10. REASSESSABLE IN THE EXTRAORDINARY CALL.

Experimentality: 40% Exercices memory. The delivery of the memory by the work group is mandatory. NOT RE-ASSESSABLE. Being a non re-assessable activity, there is no minimum score required to pass. However, the mark obtained (whatever it may be) will do average with the theory. To proceed to calculate the final mark, theory must be passed with a mark of 5,00 or higher, as indicated above (it is mandatory). Once theory is passed, subject is passed only if average mark between theory and experimentality is 5,00 or higher (it is mandatory).

EVALUATION SYSTEMS -1-	EVALUATION ACTIVITIES							
	Activity	**Nature**	**Modality -2-**	**Type**	**Minimun mark**	**Weighting -3-**	**Period**	**Contents**
ES 2	Theory written text	Individual	Onsite	Reassessable	5	60%	Ordinary (and if necessary extraordinary) call.	Written test related to the theoretical contents of the subject
ES5	Report preparation: Written memory containing all of the exercices	Groupal	Onsite	NON-Reassessable	NO	40%	Week 15	Report containing the resolution of the exercises corresponding to the experimentality

1 Evaluation Systems (ES) indicated in the subject's file in the degree's Verification Report

2 Assessment activities can be completed online only for online degrees.

3 Must add up to 100%.

3.- Exams review:

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

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4.- Anticipated call.
The student who has requested the anticipated call must contact the professor responsible for the course as soon as possible so that he/she can provide the necessary information and/or material for the evaluation, which will be similar to the one followed by the rest of the students enrolled in the subject.

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.

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

Título: Bioinformática con Ñ: Principios de Bioinformática. **Coordinadores y editores:** Sebastián, A. and Pascual-García, A., **ISBN 13:** 978-84-617-1976-X. **Edición y año:** 1ª edición, 2015 (diferentes actualizaciones de capítulos independientemente). **Acceso libre:** https://zenodo.org/communities/bioinfconn/

Título: Bioinformática: el ADN a un solo clic. Autor/es: David Roldán Martínez. **Editorial:** Ediciones de la U / RA-MA S.A. Editorial y Publicaciones. **ISBN 13:** 978-8499645285. **Edición y año:** 1ª edición, 2015.

Title: Introduction to Bioinformatics. **Author/s:** Arthur M. Lesk. **Editorial House:** PAPERBACKSHOP UK IMPORT. **ISBN 13:** 978-0198794141. **Edition&Year:** 5th edition, 2019.

Title: Bioinformatics and Functional Genomics. **Author/s:** Jonathan Pevsner. **Editorial House:** Wiley-Blackwell. **ISBN 13:** 978-1118581780. **Edition&Year:** 3rd edition, 2015.

Título: Texto Ilustrado e Interactivo en Biología Molecular e Ingeniería Genética. **Autor/es:** Ángel Herráez. **Editorial** Elsevier España, S.L. **ISBN 13**: 978-84-8086-647-7. **Edición y año:** 2da edición, 2012 (original en Castellano).

Título: Genética Humana. Conceptos, mecanismos y aplicaciones de la Genética en el campo de la Biomedicina **Autor/es:** Novo Villaverde, F.J.. **Editorial:** Pearson Educación, S.A. - Prentice Hall. **ISBN 13:** 978-84-8322-359-8. **Edición y año:** 8ª Edición, 2007.

Title: Human Molecular Genetics. **Author/s:** Tom Strachan, Andrew Read. **Editorial House:** Garland Science. ISBN 13: 978-0815341499. **Edition&Year:** 4th edition, 2010.

Título: Conceptos de Genética. **Autor/es:** Klug, W.S., Cummings, M.R., Spencer, C.A. Palladino, M.A. **Editorial:** Pearson Educación, S.A. - Prentice Hall. **ISBN 13**: 9788415552499. **Edición y año:** 10ª Edición, 2013 (en Castellano).

Title: Concepts of Genetics (Global Edition). **Author/s:** William, Klug, Michael Cummins, Charlotte A. Spencer, Michael A Palladino, Darrell Killian. **Editorial House:** Pearson Education. **ISBN 13:** 978-1292265322, Edition&Year: 12th edition, 2019 (English).

Consultation bibliography

Título: Fundamentos de bases de datos. **Autor/es:** Silberschatz, A., Korth, H., Sudarshan, S. **Editorial:** McGraw-Hill Interamericana de España S.L. **ISBN 13:** 978-8448190330. **Edición y año:** 6ª edición, 2014.

Title: Statistical Bioinformatics with R. **Author/s:** Mathur, S.K. **Editorial House:** Academic Press. **ISBN 13:** 978-0128101865. **Edition&Year:** 1st edition, 2010.

Título: Biología Molecular de la Célula. **Autor/es:** Alberts, B.L (y colaboradores). **Editorial:** Omega (versión en Castellano). **ISBN 13:** 9788428216388 . **Edición y año:** 6ª edición actualizada, 2016.

Title: Molecular Biology of the Cell. **Author/s:** Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff. **Editorial House:** Norton & Company. **ISBN 13:** 978-0393884852. **Edition&Year:** 7th edition, 2022.

Título: Biología Molecular y Celular. **Autor/es:** Lodish, H. (y colaboradores). **Editorial:** Editorial Médica Panamericana (versión en Castellano). **ISBN 13:** 9789500606264. **Edición y año:** 7ª edición, 2016.

Title: Molecular Cell Biology. **Author/s:** Harvey Lodish, Arnold Berk, Chris A. Kaiser. **Editorial House:** W. H. Freeman & Co. **ISBN 13:** 978-1319365493. **Edition&Year:** 9th edition, 2021.

IX.-Professors

Name and surname	MARÍA GALÁN ARROYO
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Department	Ciencias Básicas de la Salud
Campus	Fuenlabrada
Category	Profesor/a Contratado/a Doctor/a
Academic degree	Doctor

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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	3
Number of sexennia	3
No. of positive evaluations by Docentia	1
Name and surname	ÓSCAR DE LUIS JIMÉNEZ
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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	4
Number of sexennia	1
No. of positive evaluations by Docentia	6

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