

**COURSE DATA****Data Subject**

Code	44778
Name	Bioelectricity
Cycle	Master's degree
ECTS Credits	3.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
2231 - Master's Degree in Biomedical Engineering	Faculty of Medicine and Odontology	0	Second term

Subject-matter

Degree	Subject-matter	Character
2231 - Master's Degree in Biomedical Engineering	15 - Bridging courses	Optional

Coordination

Name	Department
RAMOS SOLER, DAVID	285 - Pathology

SUMMARY

This course deals with the theoretical aspects of bioelectricity, focusing on the generation and propagation of bioelectric signals in biological tissues. The course comprises the following parts:

1.- A first block focused in the electrical conduction in organic media due to passive forces (diffusion and electric field, ion channels and exchangers) and active (ionic pumps), to define the concept of resting membrane potential. The constitution and electrical properties of the cell membrane, voltage-current characteristics and equivalent circuit are then studied. The voltage-clamp and patch-clamp techniques are described and presented, and the basis of the membrane models are established.



2.- A second block in which the action potential is studied, using the equivalent circuit of the membrane to analyze the subthreshold stimulation and the triggering of the action potential, and also introducing the concepts of refractoriness and restitution. Finally, we study the propagation of action potentials along unmyelinated and myelinated axons and cardiac fibers using the theory of cable and transmission lines.

3.- A third block in which the problem of extracellular signals is addressed. The mathematical bases of the relationship between the intra and extracellular potentials are established, analyzing the cases of nerve fibers, cardiac and muscle cells, establishing the theoretical basis of the EEG, ECG and EMG.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is advisable (but not essential) that the students enrolled in the subject have previous knowledge of the following (or similar) subjects:

- * Biophysics: protein structure (primary, secondary and tertiary structure, alpha helices and beta folds) *
- Physics: field theory (concept of conservative field and gradient, divergence and rotational operators) *
- Morphology at the cellular level: structure of the muscle and nerve cells, structure of the cell membrane, generic concept of action potential and extracel

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

English version is not available

DESCRIPTION OF CONTENTS

1. Introduction to Bioelectricity

Bioelectricity: introduction, fundamentals and multiscale nature.

**2. Ionic currents**

Electrical conduction through the cell membrane. Electrical model of the excitable cell. Mathematical model of an ion channel.

3. Action potentials

Bioelectric foundations of action potentials. Action potentials in the nervous system. Action potentials in skeletal muscle. Action potentials in the heart.

4. Bioelectric propagation

Action potential propagation in nervous fibers. Action potential propagation in the myocardium. Bioelectric foundations of cardiac arrhythmias.

5. Extracellular potentials

Extracellular potentials generated by the nervous system (EEG). Extracellular potentials generated by the muscle (EMG). Extracellular potentials generated by the heart (EKG).

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Development of group work	7,00	0
Development of individual work	5,00	0
Study and independent work	20,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	5,00	0
Preparation of practical classes and problem	1,00	0
Resolution of case studies	2,00	0
TOTAL	75,00	

TEACHING METHODOLOGY

In the theory classes, dynamic power point presentations will be used to help understand the theoretical concepts. Students will have this material available in static (pdf) and dynamic (flash) format. The blackboard will be used only for demonstrations and clarifications. In the practical classes, the students shall address a theoretical problem related to bioelectricity and use computer simulation to solve it.



EVALUATION

The mark will be the result of three evaluation acts:

- 1.- A multiple choice test-type exam (value of 80% of the final mark)
- 2.- A report corresponding to a practical session related to single cell bioelectricity (value of 10% of the final mark)
- 3.- A report corresponding to a practical session related to extracellular bioelectricity (value of 10% of the final mark)

REFERENCES

Basic

- Referencia b1: Bioelectricity (Robert Plonsey)
- Referencia b2: Bioelectrónica : señales bioeléctricas (José María Ferrero Corral)
- Referencia b3: Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields (J. Malmivuo and R. Plonsey)

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

English version is not available

1. Contenidos

Se han impartido todos los contenidos teóricos del curso. Las clases teóricas terminaron, como estaba previsto, el 30 de marzo. Todas las clases fueron presenciales (anteriores al decreto del estado de alarma), salvo las dos últimas que se impartieron en su totalidad de manera online mediante el programa Teams.

En cuanto a las prácticas, el contenido es el previsto pero se ha retrasado la fecha de entrega de las memorias hasta el 15 de mayo para favorecer la calidad de los trabajos, visto que se han de realizar de manera individual y on-line.



2. Volumen de trabajo y planificación temporal de la docencia

No se añaden ni se eliminan actividades, aunque se retrasa la fecha de entrega de las memorias de prácticas.

3. Metodología docente

Las últimas dos clases teóricas del curso se impartieron de forma remota (online utilizando el programa Teams) por corresponder a fechas posteriores al decreto del estado de alarma. El resto de clases teóricas fueron anteriores y se impartieron con normalidad. En cuanto a las prácticas, se está en proceso de grabar sendos videos explicativos del uso del software de simulación. Los trabajos se realizarán de manera individual y se entregarán las memorias en una fecha posterior a la inicialmente prevista. Las dudas se atenderán por correo electrónico y mediante una sesión adicional on-line grupal utilizando Teams.

4. Evaluación

Se ha cambiado el sistema de evaluación. Las prácticas dejan de ser obligatorias. El peso del examen en la nota final será del 100%, pero las prácticas (ahora voluntarias) podrán sumar hasta 1.0 punto sobre la nota del examen. Lógicamente, y a pesar de ello, la nota final de la asignatura no podrá ser superior a 10 puntos.

5. Bibliografía

No hay cambios.