COURSE DATA

DATA SUBJECT

Code: 40142
Name: Cellular and molecular neurobiology
Cycle: Master's Degree
ECTS Credits: 12
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
2074 - Master's Degree in Basic and Applied Neurosciences	Facultat de Ciències Biològiques	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2074 - Master's Degree in Basic and Applied Neurosciences	Cellular and molecular neurobiology	COMPULSORY

COORDINATION

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SUMMARY

The Cellular and Molecular Neurobiology module is a compulsory subject in the first semester of the Master's Degree in Basic and Applied Neurosciences. The module consists of 12 ECTS credits and covers a wide range of content, including knowledge of the development, structure, and function of nerve cells (neurons and glial cells), knowledge of cellular compartmentalization in neurons and an understanding of the processes of intraneuronal trafficking and synaptic transmission, as well as an understanding and use of experimental systems and methods used in cellular and molecular neurobiology research. It also covers neuronal electrophysiology and synaptic plasticity. All of this is aimed at helping students acquire an integrated view of the structure and the various mechanisms involved in the function of neurons and glial cells.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

COMPETENCES / LEARNING OUTCOMES

2074 - Master's Degree in Basic and Applied Neurosciences

Adquirir destrezas en el manejo de las metodologías empleadas en las neurociencias y en el registro anotado de actividades, así como en el manejo de programas informáticos para la obtención y análisis de los datos y la exposición de los resultados

Adquisición de una visión integrada de los diversos mecanismos implicados en la función de neuronas y células gliales.

Comprender las aproximaciones experimentales y sus limitaciones, así como interpretar resultados científicos en neurociencias y saber elaborar y redactar informes que los describan

Comprensión y manejo de los sistemas experimentales y métodos utilizados en la investigación en neurobiología celular y molecular.

Conocer los principios éticos y legales de la investigación científica en neurociencias

Conocimiento de la compartimentalización celular en neuronas y comprensión de los procesos de tráfico intraneuronal y transmisión sináptica

Conocimiento de la electrofisiología neuronal y la plasticidad sináptica. Conocimiento de la fisiología de las células gliales.

Conocimiento de la estructura y funcionamiento de las células nerviosas (neuronas y células gliales).

Saber aplicar el método científico a los estudios en neurociencias y poseer el espíritu crítico requerido para distinguir la información científica rigurosa de la pseudociencia

Saber comunicar el conocimiento sobre neurociencia y sus implicaciones a públicos especializados y no especializados de un modo claro y sin ambigüedades, usando la lengua propia y el inglés.

Saber trabajar de manera responsable y rigurosa en el laboratorio, considerando los aspectos de seguridad, manipulación y eliminación de residuos así como del correcto uso de los animales de experimentación y los principios éticos para la investigación en humanos.

Saber trabajar en equipos multidisciplinares y diseñar estrategias experimentales multidisciplinares en el ámbito de las neurociencias para la resolución de problemas biológicos complejos

Ser capaz de aplicar las técnicas de búsqueda, identificación, selección y recogida de información científica especializada, así como de los métodos que se han de tener en cuenta a la hora de examinar críticamente cualquier clase de fuentes y documentos científicos.

Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.

Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.

Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.

Students should demonstrate self-directed learning skills for continued academic growth.

Students should possess and understand foundational knowledge that enables original thinking and research in the field.

DESCRIPTION OF CONTENTS

THEORETICAL CLASSES

Structural Basis of Neurobiology

Topic 1. General structure of the neuron. Neuronal diversity. Dendrites and dendritic spines. Axons. The neuronal soma, organization of the nucleus, cytoplasm, and organelles.
Topic 2. Neuronal polarity and compartmentalization. Components and assembly of the neuronal cytoskeleton. Axonal flow. Protein trafficking and targeting.
Topic 3. Diversity of synapses. Electrical synapses. Structure of the chemical synapse. Neurotransmitter release and reuptake. Vesicular cycle. Molecular mechanisms of vesicular release.
Topic 4. Glial cells. Astroglia and the blood-brain barrier. Ependyma and choroid plexuses. Oligodendroglia, Schwann cells, and myelination. Microglia. Foundations of Neurohistology. Basic organization of the CNS and PNS.

Neuronal excitability, synaptic plasticity, neurochemistry, and neuropharmacology

Topic 5. Properties of the excitable membrane. Membrane potential and action potential: Hodgkin and Huxley model, functional diversity of ionic conductances. Voltage-gated ion channels.
Topic 6. Synaptic transmission: Presynaptic and postsynaptic mechanisms. Postsynaptic potential. Synaptic plasticity: Hebbian model and molecular mechanisms. Modulation receiver. Synaptic integration.
Topic 7. Neurotransmitters and hormones. Agonist and antagonist drugs: mechanisms of action on receptors, synthesis, degradation, and reuptake enzymes.

Development of the Nervous System

Topic 8. Molecular aspects of neural tube development and morphogenesis of the vertebrate nervous system: Central (CNS) and peripheral (PNS) nervous system.
Topic 9. Neurogenesis and gliogenesis. Generation of neuronal diversity. Gene regulation of the neurogenic process.
Topic 10. Neural migration and positioning: radial and tangential migrations. Cellular and molecular

mechanisms of neuronal migration.
Topic 11. Generation of neuronal circuits. Axonal growth and guidance mechanisms. Synaptogenesis.
Topic 12. Trophism and neuronal death during development. Neurotrophic factors. Neurotrophic hypothesis.

Molecular Neurobiology

Topic 13. Primary cultures of neurons and cell lines of the nervous system.
Topic 14. Introduction to gene regulation. Gene regulation and cellular diversity in the nervous system. Regulation of synaptic plasticity at the transcriptional and translational levels.
Topic 15. Molecular tools and in vivo detection of neurons and neuronal processes. Imaging techniques and labeling with fluorescent proteins: GFP and related proteins. Visualization of neuroreceptor synthesis and assembly.

PRACTICAL CLASSES

The practical sessions aim to complement the knowledge acquired in theory. The practical sessions are divided into two sections:

1. Study of the effect of various treatments/pathologies in animal models. Study of the process of neurogenesis.

Observable cellular alterations are analyzed, and staining is performed to highlight them. Special attention is paid to stains related to brain proliferation and maturation, as well as to the recognition of brain regions (hippocampus, neocortex, cerebellum, spinal cord). The following will be used in this section:
a. Basic stains in the adult nervous system: Nissl stains, histochemical stains (Timm/diaphorases).
b. Golgi stains.
c. Immunohistochemical stains (proliferation, maturation, structural plasticity, brain cell types, inhibitory neuron subpopulations).

2. Analysis of electrophysiological recordings: field potentials

In all practical sessions, the instructor will explain a series of concepts and tools in the first part of the session (approximately 15-30 minutes), leaving the remaining time, up to 3 hours, for students to practice and address any questions they may have.

GROUP TUTORIALS

Group tutorials will be held at the beginning of the course, which will introduce the basic concepts of molecular biology and cell structure necessary for continuing the rest of the course.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	15,00
Theory	43,00
Seminar	1,00
Other activities	4,00
Laboratory	14,50
Total hours	**77,50**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	209,50
Preparation of lessons	13,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**222,50**

TEACHING METHODOLOGY

The methodologies used will include:

A lecture with active participation through discussion of the most complex aspects and the resolution of doubts and questions.

Laboratory practices with sample handling, problem-solving, practical scenarios, preparation of practice reports, etc.

Discussion, reflection, and preparation of reports on practical tasks.

EVALUATION

The assessment of the knowledge and skills acquired by students will take into account all aspects of the learning process. In addition, in order to assign a numerical grade to the level of knowledge and skills acquired by the student, assessment tests will be conducted related to the different learning activities developed, namely:

Assessment of theoretical knowledge (65%)

An assessment of the concepts covered in the theoretical sessions will be conducted, which will include an exam at the end of the semester. The test will be scored out of 10, with a passing score of 5.

Assessment of practical knowledge and skills (20%)

The assessment will include an exam at the end of the semester. The test will be scored out of 10, with a passing score of 5.

Assessment of the use of tutoring (15%)

An assessment of the concepts covered in the initial tutoring sessions will be conducted with an exam at the end of the sessions. The test will be scored out of 10 and a passing grade of 5 will be required. In any case, it will be necessary to pass this section to be able to pass the subject.

REFERENCES

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