CURRICULUM

The master's degree consists of a total of 60 ECTS credits throughout an academic year. It is structured in two semesters. In the first, compulsory subjects (40.5 ECTS) will be taken. In the second, students will take an optional subject (4 ECTS), and complete the Master's Degree Work (15 ECTS). Training is face-to-face and taught in English.

1. Common Modules

Advances in Genetic Analysis and Embryology of Different Animal Models (6 ECTS)

- Fundamental concepts in developmental genetics
- Methods and logic for high-throughput genetic analysis in Drosophila
- Transposable elements and artificial derivatives as tools for genetic analysis in Drosophila
- Murine genetics: Transgenesis, Genetic Mosaics, LoxP-Cre and FRT-FLP
- Zebrafish as a model for developmental biology
- Gastrulation and determination of the embryonic axes
- Neural Induction
- Epithelial-Mesenchymal Transition

Advances in the Study of Neural Communication: From the Cellular Level to the Whole Animal (6 ECTS)

- Electrical signals in the nervous system:

— Ionic currents and action potential
— Voltage-dependent conductances
— Encoding of the electrical signal
— Ionic channels and transporters

- Intracellular signalling:

— General principles of celular signalling
— Nitric oxide as a signalling molecule in the nervous system
— Control of nucleo-citoplasmyc protein transport
— Modulation of neuronal function by protein kinases and phosphatases
— Regulation of gene expression and protein synthesis
— Role of calcium in neuronal signalling

New Developments in the Study of the Organization and Cellular Components of the Nervous System (6 ECTS)

- Neuroanatomy:

— General introduction to the CNS
— Anatomy of the Spinal Cord, Rhombencephalon and Cerebellum
— Anatomy of the Mesencephalon and Diencephalon
— Anatomy of the Telencephalon

- Cellular components of the nervous system:

— Cell types of the NS. Morphologic and functional types of neurons. Structure of dendrites and axons
— Intercellular contacts. Types of sinapses. Structure of neuromuscular junction
— Glial cells. Oligodendrocytes and Schwann cells. Functions of astrocytes and microglia. Neuron-glia interactions
— Structure of perypheral nerves. Axonal myelination
— Axonal transport

- Practicum:

— Dissection of the human brain. Students will visit the Dissection Room of the Faculty of Medicine and will review the theoretical classes, in sagittal, coronal and horizontal sections of fixed human tissue. A human brain will be dissected to analyze the relationships between the different anatomical structures

- Practicum:

— Microscopic anatomy of the murine brain. Students will review and identify in the microscope the correlation of basic subdivisions of the human brain in a mouse brain

Synaptic Plasticity in Learning and Memory. Sensory Processing (6 ECTS)

- Synaptic transmission and plasticity:

— Neuronal communication and synaptic transmission. Electrical synapses and gap junctions
— Chemical synapses I: pre-synaptic mechanisms. Quantal neurotransmiter release and the role of calcium
— Chemical synapses II: Molecular mechanisms of neurotransmiter release

— Chemical synapses III: Post-synaptic mechanisms and synaptic integration
— Neurotransmiters and receptors I: glutamate receptors
— Neurotransmiters and receptors II: ACh, GABA and others
— Synaptic plasticity

- Sensorial processing:

— General features of sensory paths
— Visual system
— Auditory and somatosensory systems
— Systems Neurophysiology
— Plasticity
— Higher cognitive functions

Central Facility of Animals and Cell Cultures (6 ECTS)

- General principles for use of common facilities
- Animal models in neuroscience
- Procedures of cell culture

Acquisition of Functional Images and Image Analysis (6 ECTS)

- Basic concepts in image technologies
- Practical Aspects of Live Image Acquisition
- Image analysis in the context of neuroscience
- Functional magnetic resonance imaging in small animals

Neuroscience Today (4.5 ECTS)

- Biology and neuroscience throughout its history
- Current Neuroscience Topics: A Multidisciplinary Approach
- Research seminars of the Instituto de Neurociencias

Neuropathology (3 ECTS)

- Neuropsychopharmacology of neurological and psychiatric diseases
- Development of cellular therapies for the treatment of neurodegenerative disorders: Alzheimer's, Parkinson's and Amyotrophic Lateral Sclerosis
- Axonal myelination and neurological disorders
- Genetic, molecular and cellular bases of mental retardation
- Neurochemical mechanisms involved in pain and analgesia
- Neurological changes associated with drug addiction
- Role of molecular pharmacology in the study of cognitive alterations

- Physiology and pathology of learning and memory processes

New Therapies (3 ECTS)

- Cell therapy in the treatment of neurological diseases
- Neuropathology of genetic and developmental alterations
- Clinical diagnosis methods. Exploration of the central and peripheral nervous system
- Cell therapy for treatment of ALS
- Stereotactic surgery for the treatment of Parkinson's disease
- Current treatment of Alzheimer's disease
- Comorbidity studies

Master's Degree Research Work (15 ECTS)

Development of an original and unpublished scientific work in the field of neuroscience. The student can choose the specific subject between the offered and that are framed in the lines of work of the Institute of Neurosciences.

2. Optional Modules

Developmental Neurobiology: From Neurogenesis to Circuit Formation (4.5 ECTS)

- Neurogenesis:

— Genetic mosaics as a tool for the dissection of cellular functions
— Determination of precursors and specification. Neurogenic genes. Lateral inhibition
— Asymmetric cell divisions: generation of neuronal diversity
— Control of neural proliferation and differentiation in the CNS

- Neuronal migration and differentiation:

— General concepts of neuron migration
— Neuron polarization. Role of the cytoskeleton
— Neuron migration: pyramidal neurons vs. GABAergic interneurons

- Axon guidance:

— The development of the visual system as a model for the study of axon guidance and target recognition

— Directional navigation versus fasciculation

- Synaptogenesis:

— Formation of synapses
— Stabilization and refinement of synapses

- Corticogenesis:

— Early neural populations in the development of the cerebral cortex
— Role of intrinsic and extrinsic factors in the regionalization of the cerebral cortex
— Formation of cortical gyri

From ionic channels to information processing: A functional approach (4.5 ECTS)

- Molecular and cellular bases of synaptic transmission:

— Biophysics and pharmacology of ion channels
— Molecular mechanisms of neurotransmitter release
— Synaptic transmission in the cerebral cortex

- Molecular and cellular bases of sensory transduction:

— Experimental models for the study of sensory transduction
— The cornea as a model for the study of pain
— Electrophysiological recording of TRP channels. Interpretation of experimental recording.
— Practical sessions (cultures and image recording / electrophysiology in sensory neurons)

- Processing of visual information. Functional architecture of retinal, thalamic and cortical receptive fields
- Finding a form: emergence of orientation selectivity in the primary visual cortex as a model of cortical functioning
- Serial and parallel information processing in the cerebral cortex
- Visual objects in context: What the visual arts tell us about perception
- Receptor fields of the mouse vibrissae: Functional architecture, development and plasticity
- Processing of somatosensory information, from synapses to behaviour
- Anatomical, functional and effective connectivity in the brain
- Synaptic plasticity and network reorganization
- Deep brain stimulation (DBS). Magnetic stimulation