COURSE DESCRIPTION

2019

HELLENIC REPUBLIC,

NATIONAL

AND KAPODISTRIAN

UNIVERSITY OF ATHENS,

DEPARTMENT OF BIOLOGY

Athens International Master's Programme in Neurosciences

CONTENTS

INTRODUCTION

The purpose of the postgraduate program «Athens International Master's Programme in Neurosciences» is to provide high quality graduate education at the Master of Sciences (M.Sc.) level in the scientific field of neuroscience.

The postgraduate program of studies leads In the award of a "Postgraduate Specialisation degree" in Neurosciences (Master of in Neurosciences) after full and successful completion of studies based on the curriculum

The "Athens International Master's Programme in Neuroscience" is operated jointly by the:

Department of Biology of the National and Kapodistrian University of Athens
Department of Nursing of the National and Kapodistrian University of Athens
Department of Dentistry of the National and Kapodistrian University of Athens
School of Medicine of the National and Kapodistrian University of Athens
Foundation for Biomedical Research of the Academy of Athens
The National Center for Scientific Research "Demokritos",
Hellenic Pasteur Institute
Biomedical Sciences Research Center “Alexander Fleming”

The Goddess of Research

DESCRPTION OF THE COURSES OF THE INTERNATIONAL MASTER'S PROGRAMME IN NEUROSCIENCE

FIRST SEMESTER

DEVELOPMENTAL NEUROSCIENCE

Co-Coordinators

Rebecca Matsas, Research Director, Head of Department of Neurobiology, Hellenic Pasteur Institute
Panagiotis Politis, Principal Investigator, Biomedical Research Foundation, Academy of Athens

Teaching hours and weekly schedule

This is a 1st semester about 3 weeks course that corresponds to 4 ECTs and 35 total hours of teaching including student presentations.

The course will take place in October-November and the weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive three-week course focused on cellular, molecular and biochemical aspects of developmental neurobiology and neuroscience. The courses will include lectures by established researchers with diverse and complementary academic profiles. The main emphasis of the course will be on the complex cellular events and signaling cascades that occur during embryogenesis that lead to generation of the nervous system. Our goal is to provide a systematic introduction to the molecular mechanisms that control cell fate specification, differentiation, and function of neural cells during mammalian brain development. An additional aim is to discuss nervous system plasticity in the adult brain and particularly how the presence of adult neural stem cells may contribute to brain repair strategies. Special attention will be given to describe the key methodological advances and research tools, developed in the last few years, which have changed our view about the formation of the mammalian brain. Therefore, this course will provide a contemporary overview of neural development for post-graduate students with some background in cell biology.

Course Overview

This course aims: a) to introduce participants to the major issues of developmental neuroscience, b) to familiarize students with the wide range of research approaches, tools and methodology currently used to study the development of the mammalian nervous system, c) to discuss the concept of neural stem cells during development and in the adult and d) to encourage students to develop the skills required for a meaningful appreciation of experimental strategies and research articles.

This course will cover recent advances in understanding the molecular and cellular events underlying cell fate specification and differentiation, migration, axon guidance, synapse formation, the critical role of neurotrophic factors, and cell death as a developmental process. Pathologies arising from failures of these processes will be discussed. In particular, the lectures will cover the following general subjects:

- Neural Induction
- Neural tube formation and patterning
- Cortical & Cerebellar Neurogenesis
- Regulatory mechanisms of cell cycle progression/exit
- Neuronal migration and differentiation
- Axon Guidance & Adhesion Molecules
- Trophic factors and programmed cell death during nervous system development
- Synapses: formation, function and plasticity
- Development of neural circuits
- Development of the neuroimmune system
- Gliogenesis, myelination, remyelination
- Neural stem cells, adult neurogenesis & neuroregeneration
- Advanced Methods in Developmental & Regenerative Neurobiology

Titles of the lectures and the names of the lecturers

A/A	Developmental Neuroscience	Lecturer
1	Neural Induction / Neural tube formation and patterning	Panos Politis
2	Cortical & Cerebellar Neurogenesis: cell cycle progression/exit, migration and differentiation	Rebecca Matsas
3	Axon Guidance & Adhesion Molecules	Maria Gaitanou
4	Trophic factors / programmed cell death during nervous system development	Nondas Doxakis
5	Synapses: formation, function and plasticity. Development of neural circuits	Nondas Doxakis/Laskaro Zagoraiou
6	Development of the neuroimmune system	Era Taoufik
7	Gliogenesis, myelination, remyelination	Florentia Papastefanaki
8	Neural stem cells, adult neurogenesis & neuroregeneration	Rebecca Matsas
9	Advanced Methods in Developmental & Regenerative Neurobiology	Panos Politis
10	XXXX	Denaxa Myrto

GROSS AND MICROSCOPIC ANATOMY OF THE NERVOUS SYSTEM

Co-Coordinators

Elizabeth O. Johnson, Professor of Anatomy
Maria Panayotacopoulou, Professor of Neurobiology

Teaching hours and weekly schedule

This a 1st semester about 3 weeks course that corresponds to 3,5 ECTs and 31 total hours of teaching including student presentations.

The course will take place in November-December and the weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive three-week course focused on neuroanatomy that includes lectures and laboratory sessions. All material will focus primarily on learning the structure of the nervous system with related focus on function for general neuroscientists. Special attention will be given to chemical neuroanatomy in order to identify and describe the neurotransmitter systems of the brain and their connections. The goal of this intensive course is that students become well versed in the structure and function of the nervous system in health and disease. Hands on laboratory sessions will allow students to learn through direct experience.

Course Overview

Interdisciplinary study of the nervous system, with the overarching theme that nervous system disorders can be understood in terms of neuroanatomical mechanisms. The course covers general principles of the development, connectivity, neurotransmitter and receptor systems, blood supply, central nuclei and tracts of the central nervous system.

- Major topographical features of the brain
- Describe the major anatomical subdivisions and functions of cerebral cortical systems
- Major interrelationships between primary brain structures
- Localize and identify brainstem nuclei
- Localize and identify brainstem tracts
- Localize and identify major somatomotor systems
- Localize and identify major somatosensory systems
- Localize and identify central sensory systems (visual, auditory and vestibular pathways)
- Localize and understand cranial nerves
- Understand and localize hypothalamic subnuclei and autonomic systems
- Understand and localize the limbic system and diencephalon

- Understand and localize the basal ganglia
- Localize and identify the blood supply of the brain, the ventricular system and meninges
- Understand the basic immunohistochemical methodology that permits the localization of neurons on the basis of their neurotransmitter expression
- Understand the basic concept of in situ hybridization for the study of gene expression in chemically identified neurons that permits the molecular investigation of the nervous system in health and disease .

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Describe and identify the components of the nervous system and the sensory organs.
2. Identify the structures of the brain, spinal cord and peripheral nervous system.
3. Describe the relationship of the structure of the nervous system to its functions: movement, sensory systems- basic functions of a living organism.
4. Describe and identify the structure and functions of the autonomic nervous system and the cranial nerves.
5. Relate the chemical and molecular anatomy of the nervous system to clinical syndromes and diseases.

Titles of the lectures and the names of the lecturers

A/A	Gross and Microscopic Anatomy of the Nervous System	Lecturer
1	Overview of the Human Brain-structure	Elizabeth Johnson
2	Brain Coverings: Meninges, Vasculature, Ventricles, CSF and Blood Brain Bariers (Emphasis on the latter)	Theodore Troupis/Spiros Georgopoulos
3	Prefrontal and Frontal Cortex-functional mapping	Sokratis Papageorgiou
4	Parietal, Temporal and Occipital Cortex-functional mapping	Elizabeth Johnson
5	White matter tractography	Fotini Christidis
6	Language centers	Constantinos Potagas
7	Structure and function of the limbic system	Dimitios Mytilinaios/ Dimitris Arvanitis
8	Hypothalamus and Autonomic Nervous System	Maria Panayotacopoulou, Panagiotis Kokotis
9	Basal Ganglia and Diencephalon	Maria Xilouri, Dimitrios Mytilinaios
10	Brain Stem and Cerebellum	Elizabeth Johnson, Dimitios Mytilinaios
11	Spinal Cord and pathways	Nicolaos Karandreas
12	Motor systems and pathways and and control of voluntary movements	Nicolaos Smyrnis
13	Sensory Systems and pathways-Vision and Visual Cortex	Irini Skaliora, Konstantinos Moutousis
14	Sensory Systems and pathways-Hearing and Balance	Dimitris Anastasopoulos
15	Sensory systems and pathways-smell and taste	Dimitris Anastasopoulos
16	Sensory systems and pathways-touch and pain	Panagiotis Kokotis
17	Sensory systems disorders	Evagelos Anagnostou
18	Cranial Nerves	Elizabeth Johnson/ Maria Piagkou
19	Chemical and Molecular Neuroanatomy / Slide demonstration	Maria Panayotacopoulou, Margarita Chrysanthou, Marianna Pagida
20	Comparative Neuroanatomy (Rodent, Porcine, primate) and atlases	Ismini Papageorgiou, George Paxinos

21	Structural and Functional Neuroplasticity	Paul Lucassen (University of Amsterdam)
22	Brain Banking	Efstratios Patsouris
23	Lab1: Introduction to Electroencephalography(following or before? the lecture on language centers)	Dionysis Pandis (EEG lab Eginition Hospital)
24	Lab2: Introduction to Electromyography and Transcranial Magnetic Stimulation (following spinal cord and pathways)	Nikolaos Karandreas (EMG lab Eginition Hospital)
25	Lab 3: Gross and microscopic anatomy of the human brain	Elizabeth Johnson, Maria Panayotacopoulou
26	Lab 4: Gross and microscopic anatomy of the rat brain	Antonis Stamatakis, Elizabeth Johnson, Maria Panayotacopoulou
27	Lab 5: Electron microscopy lab	Margarita Chrysanthou, Ismini Kloukina (EM lab Eginition Hospital)
28	Lab5: Sleep lab (following Hypothalamus or following sleep and circadian rythms of NEUROENDOCRINOLOGY session)	Dimitris Dikeos (Sleep lab Eginition Hospital)

CELLULAR AND MOLECULAR NEUROSCIENCE

Co-coordinators

Dimitra Mangoura, Professor-Investigator A, Biomedical Research Foundation of the Academy of Athens, and
Zafiroula–Iro Georgoussi, Research Director, National Center for Scientific Research "Demokritos", Athens

Teaching hours and weekly schedule

This a 1st semester about 3.5 weeks course that corresponds to 5,5 ECTs and 49 total hours of teaching including student presentations.

The course will take place in October-November and the weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This course is designed to introduce graduate students to major processes, principles, and mechanisms associated with Cellular and Molecular Neurobiology. Therefore the material will range from the mechanistic details of neuronal signaling and cellular function to how such properties utilized during normal brain function and neuropathology or substance abuse. The Course involves a series of overview lectures by leading researchers in the field, a total of fifteen Instructors from Greece and across Europe, and opportunities of presenting primary research or literature review papers by students.

More specifically, this Course will include the following major topics: overview of the neuron as the fundamental unit; cell biology of neurons and glia; ion channels and electrical signaling; synaptic transmission, integration, and chemical systems of the brain; molecular properties of neurotransmitters and their receptors; and sensory systems, from transduction to perception. Students will emerge with a great awareness of how individual nerve cells function, and neurons communicate with other cells, and of the ways that neurotransmission can provide insight into basic scientific questions, all in preparation for students own contributions as neuroscientists and biologists.

Course Overview

This is a comprehensive introductory course in Molecular and Cellular Neuroscience. Basic principles of organization and function of the nervous system will be discussed and frequent reference will be made to pathophysiology of neurological and other disorders.

- General principles of Nervous System
- Synaptic Transmission, Neurotransmitters and their Receptors
- Molecular Aspects of Neuronal Cells

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to know the fundamental principles on:

1. Neural cell biology
2. Synapse formation and neural plasticity
3. Intracellular trafficking and cytoskeleton-related processes
4. Interconnections to form nerve circuits for the passage of electric signals
5. Small molecules coupling to their cognate membrane receptors to regulate intracellular responses and biological outcomes
6. Major intracellular signalling pathways
7. Molecular biology of the sensory systems
8. Energy brain metabolism

Titles of the lectures and the names of the lecturers

A/A	Molecular and cellular neuroscience	Lecturer
	Overview of the Nervous System	
1	Overview of the Nervous System	Mimika Mangoura
2	Cell Membrane Structures and Functions; Intracellular Trafficking and Axonal transport	Mimika Mangoura
3	The Cytoskeleton of Neurons and Glia	Katia Befort
4	Basis of excitability, resting potential	Irini Skaliora
5	Passive and active properties (Action potential, cable theory)	Christos Konsoulas
6	Synapses (NMJ and central) signal integration and processing	Christos Konsoulas
	Cellular Plasticity, LTP/LTD	Irini Skaliora/Christos Comsoulas
7	Astrocytes and Microglia (Neuron/glia interactions in network activity shaping	Ismini papageorgiou
	Synaptic Transmission, Neurotansmitters and their Receptors	
8	Synaptic Transmission, Neurotransmitters and their receptors	Zafiroula-Iro Georgoussi

9	Phosphoinositides- Cyclic Nucleotides in the Nervous System	Zafiroula-Iro Georgoussi/George Leondaritis
10	Neurotransmitters I:Glutamate and GABA and their Receptors	Ada Mitsakou
11	Neurotransmitters II: Acetylcholine	Socrates Tzartos
12	Neurotransmitters III: Catecholamines	Dido Vasilakopoulou
13	Neurotransmitters IV: Purines, peptides and gases	Laskaro Zagoraiou
14	Small molecular weight G-proteins	Mimika Mangoura
15	Ca2+ signaling and Homeostasis	Panagiota Papazafiri
	Lipid neurotransmitters (cannabinoids)	Ismael Galve-Ropeth
	Molecular Biology of Neural Cells	
16	Transcription Factors in the Central Nervous System	Panagiota Papazafiri /Laskaro Zagoraiou
17	Protein synthesis and posttranslational modifications	Mimika Mangoura
18	Energy Metabolism of the Brain	Ralph Dringen
19	Molecular Biology of Vision and Olfaction	Mimika Mangoura

TECHNICAL COURSES

It is subdivided into the following parts:

A) **Technical courses I: Methodological approaches in Neuroscience, Statistics (SPSS, R programming, graphpad).**
B) **Technical courses II: Molecular Biology-Omics**
C) **Technical Courses III: Methodological approaches in Neuroscience , Microscopy-neuroimaging**
D) **Technical courses VI: Methodological approaches in Neuroscience , Experimental animal models in Neuroscience**
E) **Technical courses V: Methodological approaches in Neuroscience, Elements of Bioinformatics (big data bases).**

Teaching hours and weekly schedule

This is a 1st semester about 3,5 weeks obligatory course that corresponds to 5 ECTs and 44 total hours of teaching including student presentations.

The course will take place in December January and the weekly schedule includes about 4 hours of teaching per day every afternoon.

A) Technical courses I: Methodological approaches in Neuroscience, Statistics (SPSS, R programming, graphpad).

Co-Coordinators

Katsouyianni Klea, Professor, Scholl of Medicine, National and Kapodistrian University of Athens

Touloumi Giota, Professor, Scholl of Medicine, National and Kapodistrian University of Athens

Description

This 7 hours course is indented to cover the basic statistical principles usually applied in the biological sciences. The goal of the course is to provide the students with the ability to choose and apply the appropriate statistics for their studies.

Course Overview

The course will begin with an analysis of the hypothesis test, a statistical test used to compare two data sets for the purpose of rejecting a null hypothesis and not to indicate the more likely of two hypotheses. The students will also be introduced in the process of randomization, of making something random, for example on how to select a random sample of a population. In addition, the course will provide detailed information on some of the most commonly used distributions and an analysis of the central limit theorem which establishes that the sum of independent random variables tends toward a normal distribution although the original variables may not. Time will be allocated in the presentation of parametric and nonparametric tests and their comparison in order for the students to understand the prerequisites for applying one or the other. Special attention will be given to the multiple comparison problems and means to overcome it. The problem arises from the fact that when you are performing multiple statistical tests a fraction of them is false positives. The application of Linear, Logistic and Cox models will be also presented.

Titles of the lectures and the names of the lecturers

A/A	Technical courses: Methodological approaches in Neuroscience, Statistics (SPSS, R programming, graphpad).	Lecturer
1	Descriptive statistics, Normal and other distributions. Hypothesis testing: main principles. Errors. Meaning of statistical significance. Multiple comparisons. Central Limit Theorem	Touloumi Giota
2	Univariate parametric and non-parametric tests. Confounding variables: presence and control of confounding effects- randomization.	Katsouyanni Klea
3	Multiple linear regression, logistic regression and Cox proportional hazards models in relation to study design and the distribution of the dependent variable.	Katsouyanni Klea

B) Technical courses II: Molecular Biology-Omics

Co-ordinators

George Panayotou, Researcher A'. BSRC Alexander Fleming

Description

These series of lectures will provide

A) an overview of Next Generation Sequencing (NGS) and the most relevant biomedical NGS applications: Targeted sequencing, Whole-exome sequencing, Whole-genome sequencing, RNA-seq (mRNA-seq, smallRNA-seq, etc., approaches to study RNA structure and RNA-protein interactions), approaches to interrogate the composition and structure of chromatin (ChIP-seq, ATAC-seq, chromosome conformation capture techniques, etc.).

B) an introduction to proteomic methodologies and their application to the study of human diseases.

C) an introduction of the significance but also the challenges of applying metabolomic analysis in neurophysiology research. The students will be presented with the major changes in the way problems in life sciences are now approached in the context of the systems biology and the omic analyses revolution, focusing on brain research and the field of systems neurophysiology. The muti-step metabolomic analysis will be described and its contribution to the reconstruction of an accurate metabolic physiology map for the brain will be discussed. Experimental and computational protocol standardization challenges that need to be addressed for its vast deployment in neurophysiology research and practice will be described. An example of brain metabolomic analysis in a mouse model will be presented.

D) Examples of genetic and biochemical approaches to develop agents interfering with protein aggregation. Many neurodegenerative diseases are associated with protein misfolding and protein self-assembly, which lead to the formation of protein oligomers and/or higher-order aggregates with neurotoxic properties. Thus, understanding these pathogenic processes is of fundamental importance for neurobiology. Furthermore, chemical and biological agents interfering with protein aggregation are much sought-after factors in the quest for effective drugs against these conditions.

Course Overview

The course will cover basic principles of NGS technologies, description of the omic analysis revolution and the consequent fundamental changes in the way problems in life sciences are now approached, mass spectrometry and applications involving differential proteomics, identification of post-translational modifications and analysis of protein complexes as well as of metabolomics. Description of the multi-step experimental and computational analysis process that needs to be carefully designed and standardized for its accurate and vast application in neurophysiology research.

Furthermore, biochemical, biophysical and biological assays, which can be utilized for high-throughput screenings of chemical and biological libraries so as to discover modulators of protein aggregation will be described. Furthermore, the design, development and outcomes of recently developed biotechnological platforms for producing chemical libraries with greatly expanded diversities and for identifying chemical rescuers of pathogenic protein misfolding and aggregation in an ultrahigh-throughput fashion will also be covered.

Skills & Learning Outcomes

The objective will be to familiarize students with

1. the principles underlying NGS and the main biomedical applications in which NGS is employed
2. the experimental design of proteomic experiments and current challenges in their application to the study of human diseases.
3. the holistic perspective of biological system analysis gained from systems and network biology research and shown the complementary role of the various omic analyses in deciphering the complexity of brain function
4. metabolomic analysis and it's various experimental and computational components

5. network reconstruction and how this could contribute to the elucidation of brain metabolic physiology and the reconstruction of the entire brain connectome
6. the experimental and computational challenges that need to be considered for accurate application of metabolomics in brain research
7. state-of-the-art high-throughput approaches for monitoring neurodegeneration-associated protein aggregation and for identifying chemical and biological inhibitors of these processes.
8. recently developed biotechnological approaches for the discovery of chemical rescuers of protein misfolding and aggregation with potentially therapeutic effects against major neurodegenerative diseases.

Titles of the lectures and the names of the lecturers

A/A	Technical courses: Methodological approaches in Neuroscience, Statistics (SPSS, R programming, graphpad).	Lecturer
1	Next Generation Sequencing and its applications in Biomedicine. Genomics	Pantelis Hatzis, Fleming
2	Proteomics	George Panayotou, Fleming
3	Metabolomics	Maria Klappa
4	High throughput assays-amyloid disassembly or prevention of protein aggregation	George Skretas

C) Technical Courses III: Methodological approaches in Neuroscience , Microscopy-neuroimaging

Co-Coordinators

Dimitra Thomaidou, Senior Investigator, Department of Neurobiology, Hellenic Pasteur Institute
Stamatis Pagakis, Senior Research Scientist, Basic Research Center, Foundation for Biomedical Research of the Academy of Athens
Nikolaos Smyrnis, Associate Professor, Psychiatry Department, Medical School, National and Kapodistrian University of Athens

Description

This is an intensive three-week course centered around the study of neuroimaging technologies, that includes lectures, laboratory/hands-on sessions and participation in the acquisition and analysis of neurophysiological/neuroimaging data. All material will focus primarily on learning the different imaging systems and technologies used to study the nervous system, from conventional microscopy to advanced in vivo imaging both in laboratory animals and humans. Attention will be given on learning current digital image processing tools used to analyze/ quantify imaging data. The goal of this intensive course is to provide students with knowledge of novel, state-of-the-art imaging approaches currently used to study nervous system function. Hands on laboratory sessions will allow students to learn through direct experience.

Course Overview

Teaching and some hands-on training of a wide range of imaging tools and technologies currently used to study nervous system morphology, function and dysfunction, both in laboratory animals and humans. The course covers general principles of microscopy (both optical and electron), nuclear and MR imaging, image processing and analysis, as well as advanced neurophysiological and functional neuroimaging approaches linking microscopic analysis with behavior. More specifically, the topics covered include:

- Introduction to human brain function imaging techniques
- Anatomical Neuroimaging
- Live cell dynamics imaging
- FLIM-FRET
- FRAP, in vivo FRAP
- Mechanosensors
- Multiphoton confocal microscopy
- Intravital imaging
- Calcium imaging at whole animal level
- Optogenetics
- Neurophysiology: EEG/MEG
- PET/SPECT Imaging
- fMRI Imaging
- Electron microscopy
- Image Processing (ImageJ, Imaris, Icy)
- Image Data analysis (MATLAB)
- Functional Imaging data preprocessing and analysis (SPM)
- Neurophysiological (EEG/MEG) data preprocessing and analysis (EEGLAB)

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Know the basic principles of microscopy and the imaging systems used to study the nervous system.

2. Know the latest applications of imaging technology currently used to answer scientific questions related to nervous structure and function and dynamic cellular interactions.
3. Get in touch with software used for the processing of digital images/videos.
4. Get hands-on training on advanced microscopy and Image Analysis systems currently available in the labs of the participating course instructors.
5. Understand the design of experimental procedures used in neurophysiological (EEG/MEG) and functional neuroimaging fMRI) experiments to study human cognition
6. Introduction to the preprocessing and analysis software tools used to analyze neurophysiological and functional neuroimaging data used in the labs of participating instructors.

Titles of the lectures and the names of the lecturers

	Technical courses: Methodological approaches in Neuroscience, Microscopy-neuroimaging	Lecturer
1	Human Neuroimaging methods. EEG/MEG, PET/SPECT Imaging	Nikos Smyrnis
2	fMRI Imaging	Nikos Smyrnis
3	Light Fluorescence Microscopy: Basic theory and Modern Techniques. Advanced techniques , FLIM-FRET, FRAP	Stamatis Pagakis
4	Image Analysis: Extracting quantitative information from fluorescence microscopy images. Software presentation: Neurolucida/ImageJ	Stamatis Pagakis
5	Advanced imaging applications in the CNS of living animals: Multiphoton confocal microscopy, Calcium imaging at whole animal level, Optogenetics. Data analysis with Imaris and ICY	Mimika Thomaidou
6	In vivo optical animal imaging (fluorescence/luminescence) Advanced imaging techniques- Light Sheet microscopy (SPIM)	Vasso Kostourou
7	Principles of Transmission Electron Microscopy (TEM): Sample Preparation, Immunoelectron Microscopy, Correlative Light and Electron Microscopy, Applications of TEM in Neuroscience Research	Ismini Kloukina

D) Technical coursesIV: Methodological approaches in Neuroscience , Experimental animal models in Neuroscience

Co-Coordinators

Efthimios M.C. Skoulakis, Researcher A', Neurobiology Division BSRC Alexander Fleming
Spiros Georgopoulos, Researcher B', Biomedical Research Foundation of the Academy of Athens

Description

This is an intensive lecture course focused on popular experimental models used on Neurobiological research. The course aims to explore the main attributes of various experimental systems that makes them suitable to or preferable to address particular types of questions and the depth and generality of answers thus obtained.

Course Overview

Interdisciplinary approach to functional neurobiology and its tools including transgenics, RNA interference, particular usefulness and contributions of selected model systems. Total 33 class hours

Each system will be examined/presented along the following axes:

1. Usefulness of the model/ contributions
2. Manipulations to make transfectants/transgenics
3. Models/ examples of Neurochemistry
4. Models/ examples of Cognitive and Neurodegenerative diseases.

Models will include

1. Neuronal cells in culture
2. Caenorhabditis elegans
3. Drosophila melanogaster
4. Mouse/Rat

Detailed syllabus

1. Cultured neuron models
Advantages, uses, transfections
Models and examples for Neurochemistry, cultured systems as discovery tools

2. C elegans:
Advantages for Neurobiological research, transgenics, RNAi
Signaling, aging, disease models

3. Drosophila
Advantages for Neurobiological research, transgenics, tools
Neurogenetics, sensory and cognitive models
Cognitive and neurodegenerative disease models , pharmacogenetics

4. Mouse
Advantages for Neurobiological research, transgenics
Cognitive models and methods, neuropharmacology
Neurodegenerative models and applications
Rat models, cognitive and neuropharmacology models

Titles of the lectures and the names of the lecturers

A/A	Technical courses: Methodological approaches in Neuroscience , Experimental animal models in Neuroscience	Lecturer
1	Tissue culture models	Panos, Politis-Kostas Vekrellis-Spiros Efthimiopoulos
2	Introduction in experimental models in neuroscience	Spiros Georgopoulos
3	Rodents as experimental models in neuroscience	Spiros Georgopoulos
4	Manipulations to make transgenic mice, lab presentation	Spiros Georgopoulos
5	Papers Presentations (Presentations by the students of papers that involve use of experimental models in neuroscience)	Spiros Georgopoulos
6	Approaches to study animal behavior	Antonis Stamatakis/Irini Skaliora/Alexia Polisidis
7	The model of drosophila, usefulness and manipulations to make transgenic drosophila	Efthymios Skoulakis
	The drosophila model for studyign neurodevelopment, learning and memory	Efthymios Skoulakis
	Drosophila Models for studying cognitive and neurodegenerative diseases	Efthymios Skoulakis
	C-elegans as experimental models in neuroscience	Popi Syntihaki

Technical courses: Methodological approaches in Neuroscience, Elements of Bioinformatics (big data bases).

Co-Coordinators

Aristotelis Chatziioannou, PhD, Principal Investigator, Metabolic Engineering & Bioinformatics Program, National Hellenic Research Foundation,
Eleftherios Pilalis, PhD,Chief Technical Officer, e-NIOS Applications PC

Description

This is an intensive two and a half week course focused on computational analysis and robust interpretation of molecular data streams, generated by a broad spectrum of high-throughput experimental technologies, termed as -omics. Overall these technologies revolutionize the landscape of modern biological research, enabling adoption of holistic approaches in the study and modification of biological mechanisms, yet their efficient integration in the discovery cycle entails great challenges, due to their immense complexity. The derivation of the instrumental molecular networks, behind disease emergence and progression, requests the intelligent utilization of powerful, computational strategies, in order to single out of the millions of biological measurements, those pivotal for the disease interrogated. Moreover, it is crucial to prioritize the important cellular events, in order to be able to propose a rational, combinatorial therapeutic approach, targeting these events, with novel combinations of compounds. In this direction, the various pillars of computational analysis that aid efficient and robust integration, analysis and interpretation of high-dimensional, omic data, potentially from multiple layers of dissection (cross-omics) will be examined, as well as the respective experimental technologies they support.

Course Overview

Ultimate goal of this intensive course is that students are gaining familiarization with this broad pool of experimental technologies, under the umbrella of -omics, together with the various sorts of bio-informatic analytical algorithms and workflows, deployed at different stages and for different data-types. In addition, emphasis will be given in the meaningful integration and robust functional interpretation, in terms of the active emergent molecular modules that shape the phenotypic landscape of the biological problem interrogated, as well as the reliable association of molecular with phenotypic markers. The course will review the application of these concepts in the field of epidemiological stratification, pharmacogenomics analysis and personalized medicine.

Topics to be discussed will cover

- Next generation sequencing technologies, providing an introduction coupled by an overview of the main Next Generation sequencing methodologies (Gen-Seq, Exome seq, RNA- Seq, ChIP-Seq, etc), from the point of view of the computational analysis (de-novo / Reference Genome-based Assembly, Filtering, Signal Estimation, Differential Expression, Statistical Selection, Variant Calling)

- Microarray technologies and their processing (background correction, signal estimation, normalization, filtering and statistical selection)
- Bioinformatic methodologies for multi-layered structural and functional characterization of nucleotide and aminoacid sequences (homology based screening, ORF and gene function prediction, taxonomic and phylogenetic analysis, protein domain analysis, machine learning for functional characterization of proteins, regulatory motif analysis, hot-spot prediction, metagenomic screening)
- Translational, integrative bioinfomatic analysis of omic datasets, which highlight the critical biological processes implicated in the biological problem interrogated (integrative methodologies, enrichment statistics, ontologies and controlled vocabularies, resampling based correction, gene set analysis, pathway prioritization, pharmacogenomic knowledgebases)
- Target prioritization and diagnostic stratification discussing the methodologies for the inference of small-sized, highly informative signatures for diagnostic classification, pharmacogenomic analysis, combinatorial treatment (semantic networks, interaction networks, network inference and analysis, derivation of molecular signatures, classification and clustering methodologies, machine learning techiques)

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to define, describe and discern critical functional features of:

1. the main Next Generation Sequencing Methodologies and their fundamental computational steps.
2. the current state-of-the-art microarray technologies, popular platform configurations for various omic experimental designs, and the requisite algorithmic processing steps.
3. the main structural bioinformatic algorithmic tools that are available for the analysis and functional characterization of nucleotide and aminoacid sequences.
4. various molecular enrichment, gene set and pathway analysis tools / platforms,
5. Network based methodologies for target prioritization, connectivity with drug-related databases, geometric estimation of complexity (Principal Component Analysis) supervised (machine learning, Linear discriminant analysis, PLS) and unsupervised (clustering) classification of phenotypic categories

Titles of the lectures and the names of the lecturers

A/A	Technical courses: Methodological approaches in Neuroscience, Elements of Bioinformatics (big data bases).	Lecturer
1	Quantitative Analysis of -omics experiments (3 hours) discussing the steps of signal estimation, filtering and statistic selection of omic experiments	Aristotelis Chatziioannou
2	Next generation sequencing technologies (3 hours) providing an introduction to the main NG sequencing methodologies and the foundamentals of their analytical pipelines	Aristotelis Chatziioannou
3	From sequences to structures and interactions (3 hours) encompassing the exploratory methodologies for the hidden structural information within the universe of nucleotide and aminoacid sequences	Eleftherios Pilalis
4	Translational analysis of omic experiments (3 hours) discussing the application of a wide spectrum of methodologies, which aims to highlight the critical biological processes implicated in the biological problem interrogated	Eleftehrios Pilalis
5	Target identification and diagnostic stratification (3 hours) discussing the methodologies for inference of small-sized, highly informative signatures for diagnostic classification, pharmacogenomic analysis, combinatorial treatment	Aristotelis Chatziioannou /Eleftherios Pilalis

LAB ROTATION

Co-Coordinators

Leonidas Stefanis, Professor of Neurology and Neurobiology
Spiros Efthimiopoulos, Professor of Neurobiology

Duration and total hours of laboratory presence

This is a 8 week laboratory practical that corresponds to 12 ECTs and 400 total hours of laboratory presence. The students have the obligation to make 2 paper presentations or 1 paper presentation and one presentation on the scientific projects performed in the lab that accepted them.

The laboratory practical will take place in February-March.

SECOND SEMESTER

NEUROBIOLOGICAL BASIS OF DISEASES OF THE NERVOUS SYSTEM

Co-Coordinators

Leonidas Stefanis, Professor of Neurology and Neurobiology
Spiros Efthimiopoulos, Professor of Neurobiology

Teaching hours and weekly schedule

This 2nd semester about 3 weeks course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive three and a half-week course focused on the Genetics, the general processes that operate in several different neurological disorders, the pathology of neurological disorders, their molecular basis, as well as experimental therapeutics. The goal of this intensive course is that students become well versed with the genetic and molecular basis of the disorders of the nervous system.

Course Overview

The course covers general principles that apply to several disorders of the nervous system as well as the description and the pathology and the molecular basis of individual diseases. General principles include:

- Protein misfolding and aggregation,
- protein degradation
- Inflammation
- Neurotoxic and neurotrophic pathways

Examples of the diseases of the nervous system that will be covered include:

- Alzheimer's disease
- Parkinson's disease
- Motor Neuron Disease
- Schizophrenia
- Depression
- Triple repeat disorders
- Epilepsy
- Addiction
- Nervous System Cancers
- Brain and Spinal Cord injury

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Understand the common mechanisms involved in various diseases of the nervous system
2. Understand the genetics of neurological diseases
3. Understand and describe the molecular pathways that operate in specific disorders of the nervous system

Titles of the lectures and the names of the lecturers

A/A	Neurobiological Basis of Diseases of the Nervous System:	Lecturer
1	Neurodegenerative diseases as proteinopathies	Kostas Vekrellis
2	Genetics of Neurodegenerative diseases	John Hardy
3	Neurotoxic and neurotrophic mechanisms	Nikolaos Robakis-Spiros Efthimiopoulos
4	Protein degradation in neurodegenerative diseases	Leonidas Stefanis-Maria Xylouri
5	Inflammation	Spiros Georgopoulos
6	Disease Biomarkers	Elisavet Kapaki
7	Molecular and Cellular Biology of Alzheimer's Disease	Stefan F. Lichtenthaler-Spiros Efthimiopoulos
8	Molecular Basis of taupathies	Efthimios Skoulakis
9	Cognitive Functions and behavior in dementias	Sokratis Papageorgiou
10	Molecular and Cellular Biology of Parkinsons's Disease	Leonidas Stefanis
11	Life Style and nurodegeneration	Nikos Scarmeas
12	Motor Neuron Disease	Laskaro Zagoreou
13	Molecular and Genetic Basis of Schizophrenia	Nikos Stefanis
14	Biology of Depression	Christina Dalla, Nikolaos Kokras
15	Cognitive deficits in Schizophrenia and depression	Nikos Smyrnis
16	Trple repeat disorders	George Koutsis
17	Epilepsy	Anastasios Bonakis
18	Mechanisms of Addiction	Christina Dalla, Styliani Vlachou
19	Nervous System Cancers	Mimika Mangoura
20	Brain and Spinal Cord injury	Rebecca Matsa

NEUROPHARMACOLOGY

Co-Coordinators

Christina Dalla, Assistant Professor of Psychopharmacology, Dep. of Pharmacology, Medical School, NKUA
Katerina Antoniou, Associate Professor of Pharmacology, Medical School, University of Ioannina

Teaching hours and weekly schedule

This 2nd semester about 3 weeks elective course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive three-week course focused on neuropsychopharmacology that includes lectures from pharmacologists, clinicians, neuroscientists and other specialties. The course will also accommodate student's presentations on specific neuropsychopharmacological issues, as well as written-exercises on pharmacological experimental design.
The lectures will focus on basic principles of pharmacology (such as pharmacokinetics and pharmacodynamics), information on drug design and discovery, treatment of neuropsychiatric disorders, as well as drug-induced changes in functioning of the nervous system. Additionally, the lecturers will give an overview of the techniques and models used for the study of neuropharmacology, as well as the basics of CNS clinical research, including regulations and statistical principles.
The goal is that students will become accustomed with neuropsychiatric treatment, modelling and research. Ultimately, they will be able to pose relevant neuropsychopharmacological questions and contribute to the design of preclinical and clinical studies.

Course Overview

The course will include lectures on drug design/discovery, as well as principles of neuropsychopharmacology preclinical and clinical studies. Students will have the opportunity to present specific neuropsychopharmacological issues, as well as to perform written-exercises on pharmacological experimental design and analysis.
Most importantly, an interactive approach, with the use of poll-machines, will be used for the teaching of the neuropsychopharmacological basis, study and mechanism of action of:

- Antipsychotics
- Antidepressant drugs and mood stabilizers
- Antiepileptics
- Cognitive enhancers
- Drugs of abuse
- Antiparkinsonian drugs and drugs for the treatment of neurodegenerative diseases
- Neuroimaging ligands

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Understand basic pharmacological principles
2. Know about most classes of neuropsychopharmacology drugs
3. Know about adverse effects, drug interactions and genomics of CNS-acting drugs
4. Identify new targets for CNS treatments and pose relevant questions
5. Understand the methods used in preclinical and clinical neuropsychopharmacology
6. Contribute to the design of preclinical and clinical neuropsychopharmacology studies

Titles of the lectures and the names of the lecturers

A/A	Neuropharmacology	Lecturer
1	Basic principles: introduction/history pharmacodynamics/pharmacokinetics	Christina Dalla, Katerina Antoniou
2	Targets of drug action (neurotransmitters/receptors, monoamines, aminoacids, neuropeptides, acetylocholine, neurotrophins e.t.c.)	Achilleas Gravanis
3	Drug design/discovery	Dimitrios Vassilatis, Ioannis Charalampopoulos
4	Neurobiology, Treatment and modelling of CNS disorders: Introduction	Katerina Antoniou, Christina Dalla
6	Antipsychotics	Nikos Kokras, Nikos Pitsikas
7	Mood disorders (antidepressants and mood stabilizers)	Christina Dalla, Nikos Kokras
8	Anxiolytics and sleep inducers	Christina Dalla, Nikos Kokras
9	Antiepileptic drugs and cognitive enhancers	Costas Papatheodoropoulos, Nikos Kokras
10	Treatment of Neurodegenerative disorders and new targets	Spiros. Efthimiopoulos, Leonidas. Stefanis, Kostas Killidireas, Ioannis Sotiropoulos
11	Neurodevelopmental disorders (ADHD, autism etc) and treatment	George Chrousos, Neny Pervanidou
12	Drugs of abuse/ addiction: neurobiology, treatment, modelling	Katerina Antoniou, George Panagis, Foteini

	CNS Stimulants, CNS Depressants, Nicotine, Psychedelics, Alcohol, Cannabinoids	Delli, Thomas Paparrigopoulos, Alexia Pollisidis, Styliani Vlachou
13	Opioid receptors and new targets	Iro Georgoussi
13	Neuroimaging ligands	Minas Papadopoulos/ Ioannis Pirmettis
14	Neuropsycho-pharmacogenomics	Dimitris Dikeos
15	Basics in CNS clinical research (design, analysis and regulation/legislation), Pharmacoepidemiology	Giota Touloumi, Tina Antachopoulou

BEHAVIORAL NEUROSCIENCE IN ANIMALS

Co-Coordinators

Efthimios Skoulakis, Researcher A, BSRC Alexander Fleming
Antonios Stamatakis, Associate Professor of Biology-Biology of Behaviour

Teaching hours and weekly schedule

This 2nd semester about 3 weeks course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This course will explore the general themes and important questions in the field of animal behavior including the underlying molecular and cellular mechanisms. Topics will include the underlying genetics of behavior, behavioral development, various forms of learning, decision making, social interaction, sexual and parental behavior. The goal of this course to familiarize students with animal models emulating emotional and cognitive functions of humans.

Course Overview

- Attention & Habituation
- Learning & Memory I: Aplysia-molecular concepts
- Learning & Memory II: Mammals –Hippocampus
- Learning & Memory III: LTP & place cells
- Learning & Memory IV: Adult neurogenesis
- Learning & Memory V: Drosophila
- Learning & Memory VI: Zebra fish
- Emotions and the limbic system
- Motivation and the reward system of the brain
- Prefrontal cortex: Decision making, working memory and monitoring of behavior
- Social Interaction & aggression I-Non mammalian species 12. Social Interaction & aggression II-Mammals
- Sexual behavior
- Maternal/Parental behavior
- Effects of early life experiences on emotion and cognition

Skills & Learning Outcomes

At the end of the course the students will be acquainted with the scientific research on animal behavior and will understand the complexity of the mechanisms controlling behavior.
Goals will be to:

1. Gain knowledge of common biological terms and principles used in the study of animal behaviour

2. Comprehend behavioral terms and principles and demonstrate this comprehension via interpretation of material in lecture
3. Apply studied behavioral terms and principles to new situations
4. Analyze behavioral principles based on the ability to distinguish between facts and inferences
5. Synthesize general principles from different sub-fields of behavior to solve problems using creative thinking
6. Evaluate behavioral principles in a study of the behavioral literature

Titles of the lectures and the names of the lecturers

	Behavioral Neuroscience in Animals:	Lecturer
	Attention & Habituation	Efthimios Skoulakis
	Learning & Memory I: Aplysia-molecular concepts	Efthimios Skoulakis
	Learning & Memory II: Drosophila-1	Efthimios Skoulakis
	Learning & Memory III: Drosophila-2	Efthimios Skoulakis
	Learning & Memory IV: Mammals –Hippocampus	Irini Skaliora
	Learning & Memory V: Adult neurogenesis	Christina Dalla
	Emotions and the limbic system	Irini Skaliora
	Motivation and the reward system of the brain	Antonis Stamatakis
	Prefrontal cortex: Decision making, working memory and monitoring of behavior	Antonis Stamatakis
	Social Interaction & aggression I-Non mammalian species	Efthimios Skoulakis
	Social Interaction & aggression II-Mammals	Antonis Stamatakis
	Sexual behavior	Antonis Stamatakis
	Maternal/Parental behavior	Antonis Stamatakis
	Sleep	Anastasios Bonakis
	Student Mini-Symposium	Efthimios Skoulakis & Antonis Stamatakis

Titles of the lectures and the names of the lecturers

NEUROIMMUNOLOGY

Co-Coordinators

Constantinos Kilintireas, MD, Professor of Neurology
Lesley Probert, PhD, Research Director, Department of Immunology

Teaching hours and weekly schedule

This a 2 weeks course that corresponds to 3 ECTs and 27 total hours of student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive three-week course focused on neuroimmunology that includes lectures and student presentations. All material will focus on learning the interactions between the immune and nervous systems and their relevance to the pathology of diseases, particularly those of the central nervous system (CNS). The course will teach basic principles of immune system function, and evidence for its involvement in nervous system function and dysfunction from the study of experimental disease models and clinical data from patients with autoimmune and neuroinflammatory diseases. The goal is that students become conversant with the extent of immune system involvement in nervous system under physiological and pathophysiological conditions. The course will be interactive, with students actively participating through their own research into, and presentations of, currently developing areas in this field.

Course Overview

The course will combine basic research and clinical experience in the field of neuroimmunology to study the involvement of the innate and adaptive immune systems in the CNS under physiological and pathophysiological conditions. The course covers the general principles of peripheral and CNS immune systems, neuroimmune interactions in health and disease, animal models for the study of autoimmune and neuroinflammatory diseases of the CNS, human neuroimmune diseases and clinical experience with current immunotherapeutics for their treatment.

- Basic principles of the immune system
- Cell migration into the CNS and antigen presentation
- CNS immune system and functions in physiology and disease
- Neurodegeneration and neurorepair
- Animal models- critical appraisal as models for human neuroinflammatory diseases
- Human neuroimmune diseases
- Immunotherapeutic approaches for neurodegenerative diseases

Skills & Learning Outcomes

Upon successful completion of this course, students will:

1. Understand the structure and functions of the peripheral immune system with relevance to neuroimmune interactions.
2. Understand the components and functions of the endogenous CNS immune system.
3. Be able to critically analyse results from experimental models and assess their relevance for human disease.
4. Be conversant with the extent of immune involvement in neurological disease.
5. Be able to appreciate the benefits and limits of current immunotherapeutics, and understand open needs for new therapies, for the treatment of human diseases.

Titles of the lectures and the names of the lecturers

A/A	Neuroimmunology	Lecturer
	Basic principles of the immune system	
1	Innate immune system with relevance to nervous systems: Neutrophils, NK cells, Macrophages, Relevance for diseases of PNS and CNS (e.g. PMS, AD, ALS, PD, Schizophrenia)	Ourania Tsitsilonis
2	Adaptive immune system II: B cells, T cell-dependent/ T cell independent responses, B regs, Relevance for diseases of PNS and CNS (e.g. autoAbs to AChR, MOG, NMDAR, AMPAR, GABAR), IgG4-related disease (IgG4-RD)	Harry Alexopoulos
3	Adaptive immune system I: T cells, Antigen presentation, APC, dendritic cells, CNS Ags (e.g. HSPs, MOG, P0, DM22), T cell differentiation, Autoantigens, Central and peripheral tolerance, Relevance for diseases of PNS and CNS	Ourania Tsitsilonis
	Regulation of the immune system	Ourania Tsitsilonis
	Cell migration into the CNS and antigen presentation:	
4	Basics: Basic principles of BBB, cell migration into CNS, Cellular activation, cytokines, chemokines	Trevor Owens
5	T cell interactions with the BBB, Live imaging of cellular interactions and migration into the CNS	Naoto Kawakami
6	Clinical aspects, BBB in neurological diseases, MRI imaging and interpretation, Pharmaceuticals that cross BBB in disease	Kostas Voumvourakis
7	CNS immune system	Spiros Georgopoulos

8	Microglia: TLR and infections, IL-1β, and inflammasome, TNF	Vasso Kyrargyri
8	Neurodegeneration and neurorepair/remyelination- Mediators of neurodegeneration (calcium, apoptosis, necrosis, necroptosis)	Luca Muzio from San Raffael
9	CNS repair mechanisms: M1/M2 inflammation, alternative activation of MG, remyelination, Neural stem cells in CNS physiology and repair	Luca Muzio from San Raffael-Maria Karamita
	Animal models- critical appraisal as models for human neuroinflammatory diseases	
10	MS models I: EAE- model for the autoimmune components of MS (passive transfer models for e.g. NMDAR encephalitis, Devics, Stiff Person Syndrome)	David Baker
11	MS models II: Cuprizone-induced demyelination/remyelination	Domna Karagogeos
12	Alzheimer's disease models: APP and ApoE4 transgenics and PSNKO, scavenger receptors/microglia, success of anti TNF therapy	Spiros Georgopoulos
	Human neuroimmune diseases	
13	T cell-mediated diseases: a) multiple sclerosis, paraneoplastic- synaptic autoimmune encephalitides (NMDAR, AMPAR, GABAR etc), CIDP – chronic inflammatory demyelinating neuropathy	Nikos Grigoriadis
14	B cell-mediated diseases- T cell-dependent/ T cell-independent: a) Paraneoplastic, Autoimmune encephalitis , Myasthenia gravis, NMO - neuromyelitis optica	Costas Kilindireas
15	Autoimmune encephalomyelitis	Harry Alexopoulos
	Immunotherapeutic approaches for neurodegenerative disease	
16	Immunosuppression in neurological diseases (e.g. for PMS, aggressive RRMS, Peripheral Neuropathy, Myasthenia Gravis), Mitoxanthrone, Cyclosporine, CellSept, Copaxone)	Mary Anagnostouli
17	Cell depletion therapies, Rituximab, Occrelizumab, Alentuzumab, PLX, plasmaphoresis for AchR (MG), Aquaporin 4 (NMO), MOG (MS?), NMDA (autoimmune encephalitis). Comment, why not effective with anti-GM1 Abs for MMA, Cell death (high dose Rituximab?	Maria Evangelopoulou

18	Anti-migratory therapies, (for MS, peripheral neuropathy, CIDP), Natalizumab (Tysabri), Fingolimod (Gilenya),	Efthimios Dardiotis
19	Immunomodulatory therapies, Type I interferons – modes of action, IVIg	Efthimios Dardiotis
20	New pipeline immunotherapeutic approaches, Antigen-specific T cell tolerance (DC targeting, DNA or TCR vaccination, etc)	

NEUROENDOCRINOLOGY

Co-Coordinators

Fotini Stylianopoulou, Professor Emeritus of Biology
Efthymia Kitraki, Professor of Biology

Teaching hours and weekly schedule

This 2nd semester about 3 weeks course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This is an intensive 2-week course focused on Neuroendocrinology that includes lectures and students' presentations. All material will focus primarily on the neuroendocrine axes that control reproduction, metabolism, stress and pain responses , water & electrolyte balance and sleep-awakening rhythms. The impact of genetic and epigenetic factors on axes' function and their interactions will be also addressed. The course aims to provide a comprehensive canvas on the mechanisms of hormonal control of the nervous system function in health and disease. Students' presentations on selected topics will enhance understanding through active learning

Course Overview

The course covers the general principles of hormone actions in the central nervous system by providing the underlying mechanisms and the different levels of regulation. More specifically, lectures and students' presentations will enable to :

- Understand the central and peripheral centres participating in the neuroendocrine control
- Understand the positive and negative feedback loops participating in the neuroendocrine axes' regulation
- Understand the molecular mechanisms of neuroendocrine control
- Understand the interactions among different neuroendocrine axes
- Understand the role of genetic and epigenetic factors in the modification of neuroendocrine function
- Understand how deregulation of neuroendocrine function is linked to disease

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Describe the function of the major neuroendocrine axes in mammals
2. Describe the possible interactions among the different neuroendocrine axes
3. Describe the genetic and epigenetic impact on axes' function
4. Relate the neuroendocrine axes' dysfunction with health outcomes

Titles of the lectures and the names of the lecturers

A/A	Neuroendocrinology	Lecturer
1	Basic principles and overview	Fotini Stylianopoulou
2	The hypothalamic- pituitary- adrenal axis	Efthymia Kitraki
3	The hypothalamic-pituitary-gonadal axis and reproduction regulation	George Mastorakos
4	The hypothalamic- pituitary- thyroid axis and growth hormone	Melpomeni Peppa
5	Neuroendocrine control of food intake	Constantinos Tsigos
6	Interactions of neuroendocrine axes	Fotini Stylianopoulou
7	Neuroendocrine control of pain	Antonis Stamatakis
8	Neuroendocrine control of water and ion balance	Maria Panagiotakopoulou
9	Neuroendocrine control of sleep and circadian rhythmes	Anastasios Bonakis
10	Sexual differentiation of the brain	Fotini Stylianopoulou
11	Polymorphisms in neuroendocrine responses	Efthymia Kitraki
12	Epigenetics in neuroendocrine functions	Fotini Stylianopoulou
13	Neuroendocrine disorders	George Chrousos

ELECTROPHYSIOLOGY

Co-Coordinators

Skaliora Irene, Research Assistant Professor of Neuroscience

Consoulas Christos, Associate Professor of Physiology

Teaching hours and weekly schedule

This 2nd semester about 3 weeks course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.

The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description:

This two-week course will focus on cellular and molecular neuroscience. It will cover the mechanisms that operate to regulate neuronal excitability, dendritic and synaptic function; plasticity and neural circuits. This is an intensive course focused on cellular neurophysiology. The main aim of the course is to understand the principles of signal generation, modulation and transmission, both at the cell and circuit level. The goal of this course is to enable

Learning Resource

Kandel ER, Schwartz JH, Jessell, TM, et al. Principles of Neural Science 5th Edition (2012). McGraw-Hill NY. ISBN 0071390111

Course Overview

- Introduction lecture
- Ion channels
- Membrane potential, Nernst Equation, Goldman Equation
- Electrotonic potential
- Passive membrane properties
- Action potential
- Na+, K+, and Ca++ channels and currents
- Mechanisms of pre-synaptic release
- Synaptic transmission - ligand gated and G-protein synaptic transmission
- Neuromuscular Junction
- CNS synaptic transmission 1- excitation Glutamatergic
- CNS synaptic transmission 2- inhibition - GABAergic and Glycinergic
- CNS synaptic transmission 3- synaptic integration.
- Neural Circuits: methods of recording and analysis
- Modulation of Neural Circuits

Titles of the lectures and the names of the lecturers

A/A	Cellular neurophysiology	Lecturer
1	Basis of excitability, resting potential	Irini Skaliora
2	Passive and active properties (Action potential, τ, cable theory)	Christos Consoulas
3	Synapses (NMJ and central) signal integration and processing	Christos Consoulas
4	Synaptic modulation, neurotransmitter and receptors	Cornelia Poulopoulou
5	Recording techniques	Elias Koutsoukos
6	Dendritic recordings Ca imaging	Carsten Duch
7	Network analysis	Irini Skaliora

COMPUTATIONAL NEUROSCIENCE

Co-Coordinators

Efstratios K. Kosmidis, Assistant Professor of Neurophysiology
Vassilis Cutsuridis, Affiliated Researcher, FORTH, Senior Lecturer, School of Computer Science, University of Lincoln, UK

Teaching hours and weekly schedule

This 2nd semester about 3 weeks course that corresponds to 6 ECTs and 53 total hours of teaching including student presentations.
The weekly schedule includes about 4 hours of teaching per day every afternoon.

Description

This course provides an introduction to basic computational methods for understanding what nervous systems do and for determining how they function. We will explore the computational principles governing neural function from the single neuron to the neural network level. Specific topics will cover synaptic plasticity, learning and memory in the brain. We will make use of C++/Matlab/NEURON demonstrations and exercises to gain a deeper understanding of concepts and methods introduced in the course. The course is aimed to students of all ages eager to learn how the brain processes information.

Course Overview

Computational neuroscience is the intersection of neurophysiology, neuroanatomy, mathematical modeling and computer science. Its primary target is to describe how the brain "computes" by simplifying neuronal biology to a set of equations. As most branches of Science, it contains elements of Philosophy and Art. Emphasis will be given on mathematical descriptions and computational techniques used to study and understand neurons and network of neurons. Weekly assignments will allow students to learn through direct experience. The course will provide a glimpse of this exciting field aiming to motivate the young mind by covering the following topics:

- Mathematical modeling in neurophysiology. An introduction.
- Classical, membrane potential theory
- Electrical analogue of the cell membrane – The Lapique model (Leaky Integrate and Fire)
- Action potential theory. The Hodgkin – Huxley model
- Cable theory, multi-compartmental single neuron model
- Models of synaptic transmission (AMPA, NMDA, GABAA, GABAB)
- Models of synaptic plasticity (LTP/LTD, STDP, Hebbian, Delta rule, backpropagation, etc)
- Models of neural networks (feedforward, feedback, competitive, etc)
- Computational tools (NEURON and MATLAB)

Skills & Learning Outcomes

Upon successful completion of this course, students will be able to:

1. Understand and appreciate the integral role of computational techniques and concepts in neuroscience. Study and critique review papers relating the use of computational techniques to the broader development of theories and experimental methods in neuroscience.
2. Understand basic concepts for ion channel and single cell modeling, possibly including:
   a. I-V curves, the Hodgkin-Huxley model of action potential generation, and simple kinetic models of ion channels, integrate-and-fire approximation
   b. Mathematical representations of conductances, currents, and their relationship to dynamic changes in nerve cell behavior
3. Use these models and associated methods to predict qualitative functional outcomes or quantitative state changes when varying parameters or changing structural properties of the models.
4. Use one or more software tool that facilitates the calculation of such predictions.

Titles of the lectures and the names of the lecturers

A/A	Computational Neuroscience	Lecturer
	Lecture title	
1	Mathematical modeling in neurophysiology. An introduction.	Efstratios Kosmidis
2	Classical, membrane potential theory	Efstratios Kosmidis
3	Electrical analogue of the cell membrane – The Lapique model (Leaky Integrate and Fire)	Efstratios Kosmidis
4	Action potential theory. The Hodgkin – Huxley model	Efstratios Kosmidis
5	Dendritic functional properties. Multi-compartmental modeling	Panagiota. Poirazi
6	Kinetic models of synaptic transmission	Vassilis Cutsuridis
7	Computational tools	Vassilis Cutsuridis
8	Synaptic plasticity, learning and memory modeling approaches	Vassilis Cutsuridis
9	Network models	Vassilis Cutsuridis

LABORATORY ROTATION

Co-Coordinators

Leonidas Stefanis, Professor of Neurology and Neurobiology
Spiros Efthimiopoulos, Professor of Neurobiology

Duration and total hours of laboratory presence

This is an 8 week laboratory practical that corresponds to 12 ECTs and 400 total hours of laboratory presence. The students have the obligation to make 2 paper presentations or 1 paper presentation and one presentation on the scientific projects performed in the lab that accepted them.

The laboratory practical will take place in June-July

RESEARCH THESIS PROJECT

This is an 11 month research project that corresponds in 60 ECTs