### Testi in italiano

<table>
<thead>
<tr>
<th>Lingua insegnamento</th>
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<tr>
<td><strong>Contenuti (Dipl.Sup.)</strong></td>
<td>The course of Advanced Electrophysiology introduces electrophysiological approaches to understanding brain function. Topics include intracellular (patch-clamp) and extracellular (MEA &amp; EEG) electrophysiological recordings of ion channel, neuron, neuronal network and brain activity. The course covers foundational quantitative tools of data analysis in neuroscience: noise analysis, Markov chains, quantal analysis, correlation and convolution. It comprises frontal lessons (2 CFU - 16 hrs) and practical lessons at the bench and at the computer (1 CFU - 12 hrs).</td>
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<td><strong>Testi di riferimento</strong></td>
<td>Handbook of Neural Activity Measurements.</td>
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<td></td>
<td>Romain Brette &amp; Alain Destexhe,</td>
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<td></td>
<td>Cambridge University Press 2012</td>
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<td></td>
<td>Ion Channels of Excitable Membranes, 3rd edition</td>
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<td></td>
<td>Bertil Hille</td>
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<td>Sinauer Associates 2001</td>
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Obiettivi formativi

The objective is to equip the students with the essential conceptual and practical skills for interpreting, designing, performing and analyzing electrophysiological experiments.

D1 - Knowledge and understanding:
- Reaching an understanding of the theoretical underpinnings of electrophysiological experiments;
- Gaining familiarity with the practical aspects and technical limitations involved;
- Acquiring familiarity with the most important tools used in electrophysiological and time series data analysis.

D2 - Applying knowledge and understanding:
By the end of the course the students will be able:
- to choose the most suitable electrophysiological experimental approaches for a given scientific question;
- design and perform a patch-clamp experiment;
- design and perform a MEA experiment;
- become proficient in electrophysiological and time series data analysis;
- organize electrophysiological data in a figure suitable for publication in a scientific journal;
- read critically a scientific paper that makes use of the electrophysiology techniques.

D3 - Making judgments:
The ability to make informed judgments will be developed through the interaction with the lecturers during class time, as well as through the preparation of the final examination, which requires the student to elaborate and comprehend the topics discussed over the course.

D4 - Communication skills:
The lessons will be given using the appropriate scientific language. Students will be encouraged to interact with the lecturers and among themselves to improve their scientific vocabulary, their ability to pose questions and to expose their ideas.
The examination will give students further stimuli to improve their communication skills, demonstrate their ability to elaborate the acquired knowledge and communicate the key points in a concise and effective way.

D5 - Learning skills:
The ability to learn will be stimulated by studying and applying the concepts presented during the frontal lessons, and will be assessed through the evaluation procedures described above. The students will acquire the knowledge necessary to understand the electrophysiological techniques used to investigate brain function in health and disease.

Prerequisiti

Basic knowledge in biophysics and neurophysiology.
<table>
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<th>Metodi didattici</th>
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| Modalità di verifica dell'apprendimento | Student assessment includes:  
a) A homework assignment consisting in the analysis, figure preparation and interpretation of a set of electrophysiological data. Weight in the final score: 60%;  
b) Practicum at the electrophysiological setups. Students will be judged for their propensity for experimental work. Weight in the final score: 10%;  
c) An individual written test designed to evaluate the achievement of the expected results, as outlined by the Dublin descriptors. The test will consist of 10 multiple-choice questions (MCQs), with each correct answer earning 1 point and each incorrect answer earning 0 points. This test will be conducted on the Moodle platform and will take place in one of the University's computer rooms. Consequently, candidates may be divided into several groups depending on their number and the availability of computer workstations. Weight in the final score: 30%.  

The final mark will be a weighted average of the part a, b and c. The exam score is given on a thirty-point scale. To pass the exam, the student must achieve a score of 18/30. To attain the highest score (30/30 with honors), the student must demonstrate full mastery in the understanding, analysis and interpretation of electrophysiological data. The examination procedure is explained at the beginning of the course and is also available in the course introduction presentation. |
| Programma esteso | Bioelectricity. Learning objectives:  
- To understand how concentration gradients lead to currents (Fick’s first law);  
- To understand how charge drift in an electric field leads to currents (Ohm’s law and resistivity).  

Recording intracellular electrophysiological signals. Learning objectives:  
- To learn how we can inject currents into neurons (e.g. patch-clamp);  
- To understand how membrane capacitance and resistance allows neurons to integrate or smooth their inputs over time (RC model);  
- To understand the difference between current-clamp and voltage-clamp.  

Laboratory computer. Learning objectives:  
- To understand how a voltage-clamp amplifier works;  
- To understand signal conditioning (filtering);  
- To understand digital data acquisition (Nyquist theorem).  

Analysis of intracellular electrophysiological signals. Learning objectives:  
- To learn how to analyze voltage-activated currents (Boltzmann equation);  

Single channel recordings. Learning objectives:  
- To learn how we can perform single channel recordings  
- To understand how to interpret single channel recordings (Markov chains)  

Synaptic physiology. Learning objectives:  
- To understand quantal analysis at central synapses;  
- To learn advantages and limitations of current electrophysiological methods to study synaptic transmission, comparison and integration with optical and optogenetic approaches  

Recording of extracellular electrophysiological signals (MEA & EEG). Learning objectives:  
- To understand the origin of extracellular spike waveforms and local field
The course of Advanced Electrophysiology introduces electrophysiological approaches to understanding brain function. Topics include intracellular (patch-clamp) and extracellular (MEA & EEG) electrophysiological recordings of ion channel, neuron, neuronal network and brain activity. The course covers foundational quantitative tools of data analysis in neuroscience: noise analysis, Markov chains, quantal analysis, correlation and convolution. It comprises frontal lessons (2 CFU - 16 hrs) and practical lessons at the bench and at the computer (1 CFU - 12 hrs).

Frontal lessons:
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Recording of extracellular electrophysiological signals (MEA & EEG). Learning objectives:
- To understand the origin of extracellular spike waveforms and local field potentials
- To understand what a peri-stimulus time histogram (PSTH) and a tuning curve are
- To know how to compute the firing rate of a neuron

Analysis of extracellular electrophysiological signals (MEA & EEG). Learning objectives:
- To understand time series analysis for spike trains (Poisson processes)
- Fourier transform and power spectrum

Practical lessons:
- Functional connectivity assessed by patch-clamp recordings and optogenetics: preparation of and recording from acute prefrontal cortical slices in the whole-cell patch-clamp configuration in combination with structured illumination optogenetic stimulation;
- Cortico-thalamic oscillations assessed by multi-electrode array (MEA) recordings: preparation of and recording from acute cortico-thalamic slices using multi electrode arrays in combination with pharmacology;
- Laboratory computer: analysis of synaptic activity: data preprocessing, event detection, data and statistical analysis, graph preparation, figure preparation using dedicated software (Clampfit, IgorPro, Matlab and GraphPad).

The contents explore topics related to the objectives of the United Nations 2030 Agenda for Sustainable Development. Specifically,
N.3 Health and wellbeing
N.4 Education of quality

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<th>Codice</th>
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**Obiettivi per lo sviluppo sostenibile**