Università degli Studi di Genova – Istituto Italiano di Tecnologia

Corso di Dottorato "Neuroscienze"
Curriculum "Neuroscienze e Neurotecnologie"

Anno Accademico 2018-2019
Ciclo XXXIV

Research Themes

6 positions available with scholarship

INTRODUCTION TO RESEARCH THEMES FOR NSYN PhD positions

Candidates are asked to prepare a research project of their choice related to one or more topics of the themes listed below. The soundness and originality of the project will be part of the evaluation process.

Title: **Platinum nanoparticles in the restoration of vision in a rat model of degenerative blindness**
One of the research lines in our laboratory is the study of blindness due to photoreceptors degeneration, a pathology with no effective clinical treatment. Natural photoreceptors, having a high rate of oxygen metabolism, are continuously exposed to elevated levels of toxic reactive oxygen intermediates (ROS), which may be detrimental. The absence of retinal photoreceptors actually determines the loss of vision. There is evidence that platinum nanoparticles show broad antioxidant properties and decrease ROS levels in cellular lines. The aim of this project is to investigate whether the exogenous administration of platinum nanoparticles inhibits the progression of photoreceptors degeneration in Royal College of Surgeons rats, a classical model of degenerative blindness. To achieve this goal, we shall use a combination of *in vivo* electrophysiology (electroretinograms and visual evoked potentials), immunohistochemistry, confocal microscopy, and behavioural analysis, in our experimental model. The successful candidates should have a master degree in life sciences (Medicine, Biology, Biotechnology, Pharmacy or similar). Previous experience with *in vivo* electrophysiology and confocal microscopy will be considered a plus.
Tutor: Jose Fernando Maya-Vetencourt (maya.vetencourt@iit.it).

Title: **Epigenetics in the adult brain**
The project will study the role of RE1-silencing transcription factor (REST) in maintaining adult brain plasticity. REST is an inhibitory transcription factor that plays a fundamental role in several neurophysiological processes, and which is altered in a number of neurological disorders, including epilepsy. The research will be conducted at two levels. *In vitro* studies will be performed to analyze the molecular mechanisms mediating REST activity under normal conditions as well as upon induction of hyperexcitability. The *in vitro* findings will be complemented by an *in vivo* approach, by using transgenic mouse lines that lack REST specifically in excitatory and inhibitory neurons. The phenotypic analysis of mutant animals will be conducted through biochemical, molecular, immunochemical and behavioral techniques. The successful candidate will hold a Master degree in Biosciences (Medicine, Biology, Pharmacy, Biotechnology and similar) and have a good background

in cellular and molecular neurobiology. Experience in molecular cloning and/or in working with transgenic animals will be an advantage.
Tutor: Fabio Benfenati (fabio.benfenati@iit.it).

Title: **Modulation of blood-brain barrier permeability**
The research project will study the molecular and cellular mechanisms controlling the transcellular and paracellular permeability of the blood-brain barrier (BBB). With the support of structural and computational studies, and by eventually engineering optogenetic probes, this study aims at finding peptides or small molecules able to transiently and reversibly open the BBB. This approach will be applied to: (i) devise new drug delivery strategies for treating central nervous system (CNS) diseases; and (ii) rescue BBB functionality in genetic brain disorders in which important components of the barrier are mutated. The successful candidate will hold a Master degree in Biosciences (Medicine, Biology, Pharmacy, Biotechnology and similar) and have a good background in cellular and molecular neurobiology. Previous experience with patch-clamp electrophysiology and in vitro/in vivo BBB models will be an advantage.
Tutor: Fabio Benfenati (fabio.benfenati@iit.it).

Title: **Neurotrophin signaling and neuroinflammation**
The focus of the research project will be the analysis of the cellular and molecular mechanisms mediating neurotrophin signaling in the adult brain, by using transgenic mouse lines that are defective in neurotrophin signaling. The phenotypic analysis of mutant animals will be conducted through biochemical, cell biology, histological and behavioral techniques. Following a parallel and complementary approach, we will also study the molecular mechanisms of neuroinflammation, by focusing on the alteration of trophic signals and of gene transcription in in vitro/in vivo models of inflammation. The successful candidate will hold a Master degree in Biosciences (Medicine, Biology, Pharmacy, Biotechnology and similar) and have a good background in cellular and molecular neurobiology. Some experience in working with transgenic animals will be an advantage.
Tutor: Fabrizia Cesca (fabrizia.cesca@iit.it).

Title: **Cellular mechanisms of perception**
The cerebral cortex is an extremely complex network of highly interconnected neurons which mediate fundamental functions of the brain, such as attention, perception and motor coordination. However, how these higher brain functions stem from the coordinated activity of the cortex's individual cellular components is unclear. This project focuses on the cellular mechanisms underlying the coding of sensory information in the mouse cortex. To tackle this question, experimental approaches including two-photon functional imaging, patch-clamp recordings and optogenetic manipulations will be coupled with advanced analytical and computational approaches. Applicants should have strong interest in both physiological approaches to monitor/manipulate cortical microcircuits and mathematical methods to describe and model neural networks.
Tutor: Tommaso Fellin (tommaso.felin@iit.it).

Title: **Neural control and biomechanics of the octopus arm hydrostatic muscles.**
The Octopus vulgaris arm is a remarkable example of muscular hydrostat where extraordinary motor capabilities are achieved despite the absence of a rigid skeleton. This structure offers both a skeletal-like support and works as an actuator for the arm movements' generation. Interestingly, cephalopod muscles are composed by uninucleated skeletal muscle cells arranged in a packed array within each muscle type. These are finely controlled and coordinated to produce a wide variety of motions such as arm bending, elongation and stiffening, three motion components fundamental to the animal behavior.
We investigate the properties of muscles at various level of organization (i.e. from single cell to fibers) and the mechanisms of neural control and coordination of muscle cell ensembles.
In particular, we employ techniques of muscle physiology, biochemistry, molecular biology and high-resolution imaging to investigate the mechanisms of force production and uncover the link between morphology and biomechanics developed in this special muscle hydrostat.
Tutor: Letizia Zullo (Letizia.zullo@iit.it).