Università degli Studi di Napoli Federico II

Phd program in Computational and Quantitative Biology

Project Proposal

Title

Multiscale approaches of experiments and simulations to study disordered membrane protein regions

Project Description

Biomolecular surfaces generate functionality in living systems as the cellular membranes that host fundamental heterogeneous processes, including biological signalling, the assembly of biomolecular machinery, the regulation of vesicular exocytosis, the action of drugs. Conventional biophysical and structural methods have obtained extraordinary results in the characterization of homogeneous systems of pure isolated components, such as conformationally defined biomolecules, but it remains a challenge to understand the properties of highly dynamical systems, particularly those carrying out their function along the fine line between structural order and disorder at the surface of biomembranes. This gap has left many of the fundamental scientific questions unanswered, such as for example the nature of transient macromolecular interactions that regulate synaptic function. Characterizing these processes, including structure, dynamics, thermodynamics and kinetics by which they occur, is of fundamental importance to understand how neurons communicate and how neuronal pathologies develop.

This project aims at innovating the scope of analytical biochemistry to enable an unprecedented characterization of biomolecular mechanisms occurring at the surface of biological membranes. These processes are crucial both to function and malfunction in the cell, and cannot be studied using conventional analytical techniques. We are carrying out a programme where multiscale methods intertwining NMR experiments and molecular simulations provide the key to answer some of the greatest challenges in the study of biochemical processes, particularly of those associated with neuronal function and neurodegeneration.

The synergy between theory and experiments is crucial to radically innovate current analytical capabilities, and in our group the methodological development is carried out *side-by-side* in both theoretical and experimental areas by a research team that has achieved world-class expertise in both biochemical experiments and molecular simulations, and in their combination. This PhD project will focus on the development and application of multiscale protein simulations interfaced with NMR data. The student is expected to have prior expertise in programming and a level of understanding of protein science. An interdisciplinary research environment and working in association with experimentalists in the lab will provide a unique training framework for the next generation of quantitative computational biologist.

Supervisor(s), Lab/Group details, other additional info.

Alfonso De Simone, Department of Pharmacy, University of Naples “Federico II”.

The lab has recently joined the University of Naples from the Imperial College London to set an interdisciplinary research programme at the interface between experiments and theory

to study transient and off-equilibrium processes involving proteins and biological membranes.
Web: https://www.imperial.ac.uk/people/a.de-simon

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