Single-molecule studies of molecular interactions at the interface. Experiments and simulations

Tutor: Jose Requejo-Isidro (CNB/IMDEA Nanociencia)

Contact:
jose.requejo@csic.es
http://sitios.csic.es/web/biophot

Biological membranes are complex mixtures of lipids and proteins that act as mechanical and electrical barrier within organisms. They are also host to highly diverse biochemical processes between proteins and lipids that regulate many physiological functions, including propagation of external signals, cell interaction with its environment, ion transport, or viral infection. Membrane association of many proteins is known to be mediated by the hydrophobic effect, which drives the insertion of part or the full protein into the membrane from the aqueous buffer, and electrostatic interactions, which contributes to recruit proteins to the membrane locally concentrating them, orienting them to favour subsequent interactions, etc. A detailed description of the role of lipids in membrane protein function is of paramount importance for the understanding of molecular events at the interfaces formed by biological membranes which, in turn, is essential for understanding biological phenomena and the basis for the development of new biomedical applications.

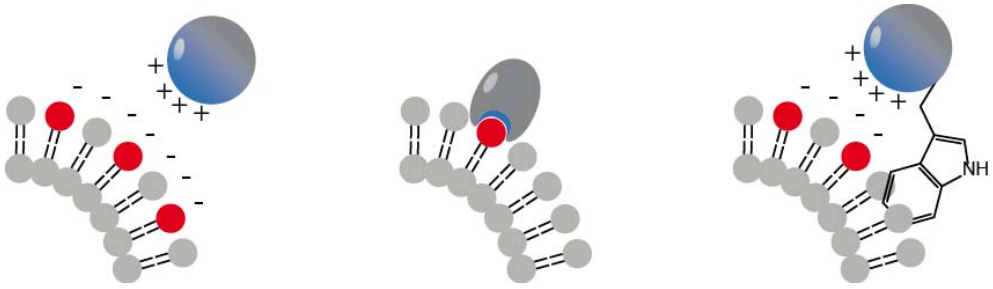

Fig. 1. Association of a peripheral protein with a membrane: Left and middle: Electrostatic interaction: Non-specific charge-driven interaction (left), sterically constrained lipid-specific interaction (middle) and combined hydrophobic and non-specific coulombic association (right).

We offer **an experimental and a computational** TFM on this subject:

1. Understand how certain biophysical properties of the membrane determine protein-lipid interactions (specifically, antibody association with the membrane) through the diffusion of a molecule on a membrane **at the single molecule level**
2. Computationally describe the diffusion of an antibody over the surface of a membrane with different biophysical properties

One of the main research interests of Dr. Requejo-Isidro has been the development of optical methodologies for the quantification of protein interactions and membrane biophysical properties and their application to relevant biological questions related to cancer and HIV. The students will join the group in its effort at unravelling the mechanisms for molecular recognition at the membrane at the single molecule level through a combination of experimental and theory approaches.

Titles of past TFMs in the group:

- 3D on-lattice stochastic reaction-diffusion simulation of protein-membrane reversible association
- All-atom study of an antimetastatic alkyl-lipid derivate in fluid bilayers
- Parameter optimisation for single-particle tracking experiments