Master Matière Condensée et Nanophysique

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Does lipid oxidation compromise the membrane affinity for biomacromolecules?

The intracellular and plasma membranes, which compartmentalize and interface the lumen of eukaryotic organelles, the cell cytoplasm and the extracellular milieu, embody levels of biological self-assembly that oxidation can intimately influence and structurally compromise. The group MCube that will host this Master project, has made seminal contributions to the understanding of the mechanisms of lipid oxidation [1,2], an unavoidable consequence of aerobic metabolism. Changes induced by oxidation on the structure and mechanical properties of the lipid membrane are better studied in model membrane systems such as Giant Unilamellar Vesicles (GUVs). These micron-sized capsules are simple biomimetic representations of the cell plasma membrane; they have become the system of choice to elucidate fundamental mechanisms involving the interactions between lipid-membranes and other bio-molecules. In this project we will investigate how lipid oxidation might compromise or enhance the interactions between the lipid membrane and several biomacromolecules such as the TAT-sequence of the HIV virus, DNA molecules or assemblies of amyloid-proteins.

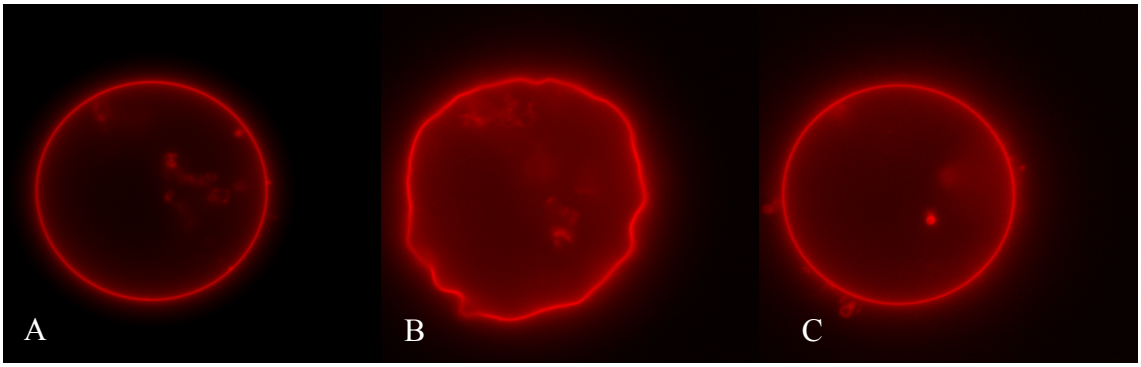

Figure 1 : Giant Unilamellar Vesicle made of POPC with the oxidative species chlorine 12 anchored within the membrane. A: before irradiation, the vesicle is well spherical. B. During irradiation, lipids do react with free singlet oxygens which increase their surface area. It gives rise to deformations of the vesicle which has kept its inner volume constant. C. The vesicle relaxes, here with the apparition of bulges.

This experimental project will consist first in the preparation of GUVs with different lipid compositions by gel assisted techniques [3], a GUV formation technique developed by the MCube group that allows encapsulating DNA, proteins or dyes within the vesicles. The sample will be then transferred to different oxidative environments and observed under a microscope to see how our "synthetic cells" respond to different biomolecules.
The project will be developed within the experimental environment of the group MCube covering a large range of optical microscopy techniques including phase contrast, bright field, epifluorescence and confocal fluorescence microscopy. The student will also acquire some expertise in quantitative image analysis, in particular for the study of the affinity between the membranes and the labeled biomolecules.

[1] Weber G., Charitat T. et al. Soft Matter 2014, Vol 10 p 4241
[2] Mertins.O Bacellarl I.O.L et al Biophys.J. 2014 Vol 106 p 162
[3] Weinberger A, Tsai FC et al Biophys. J. 2013 Vol 105 p 154