Emerging dynamics in lipid membranes

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The lipid membrane is the first point of contact with the external environment of cells and membrane-bound organelles. It ensures their entity as an active border, being involved in (re)shaping, communication, protection and survival. The quest for unraveling the properties and interactions of membranes has driven efforts to develop model membrane systems. Arguably, the optimal model system to study the plasma membrane as a major organelle would be obtained by emptying the cell interior, while modulating the composition of the resulting capsule of lipids, membrane proteins and other species; these capsules would be then directly visible under a microscope and amenable to manipulation. We cannot do that (yet), but we can use giant vesicles (10-100 mm), either synthetic, i.e. prepared from a starting well-defined mixture of molecules, or derived from the plasma membrane of cells.

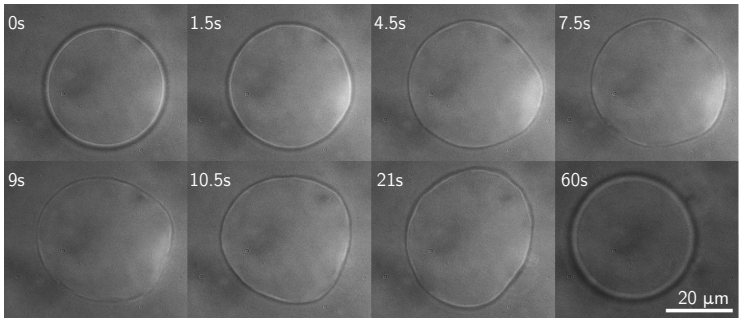

FIGURE 1 A LIPID BILAYER TEMPORARILY FLATTENS IN A REGION OF A GIANT VESICLE WHERE LOCAL REACTIONS (HERE HYDROPEROXIDATIONS) ARE IMPOSED ONTO THE LIPIDS. THE REASONS FOR THIS APPARENT NEW DYNAMIC RIGIDITY REMAIN OBSCURE.

Lipid peroxidation mediated by singlet oxygen leads to a rapid expansion of the average area per lipid. Irradiation of a phospholipid giant vesicle in the presence of an appropriate photosensitizer can thus induce a large variety of morphological changes that can influence the cell functioning. In this work, we will investigate the structural and morphological changes that are associated with lipid peroxidation. In particular we will study a dynamic flattening of the membrane surface under local irradiation, that is not understood yet.

This PhD project will be implemented within the experimental and theoretical environment of the MCube group at the Charles Sadron Institute under the supervision of Fabrice Thalmann, in strong interaction with the other group members.

[1] Lipid oxidation induces structural changes in biomimetic membranes. Weber, G.; Charitat, T., Baptista, M. S.; Uchoa, A. F.; Pavani, C; Junqueira, H. C.; Guo, Y.; Baulin, V. A.; Itri, R.; Marques, C. M. and Schroder, A. P. *Soft Matter*, **2014**, 10, 4241.

[2] Bioadhesive giant vesicles for monitoring hydroperoxidation in lipid membranes. Aoki, P.H.B.; Schroder, A.P.; Constantino, C. J. L.; Marques, C. M. *Soft Matter*, **2015**, 11, 5995.

[3] Peroxidised phospholipid bilayers: insight from coarse-grained molecular dynamics simulations. Guo, Yachong, Vladimir A. Baulin, and Fabrice Thalmann. *Soft Matter* **2016**, 12, 263.

[4] A coarse-grained model of oxidized membranes and their interactions with nanoparticles of various degrees of hydrophobicity. Su, C.; Merlitz, H.; Thalmann, F.; Marques, C.M.; Sommer J.-U. J. Phys. Chem. C, **2019**, 123, 6839.