Polymer-induced permeability of lipid bilayer membranes

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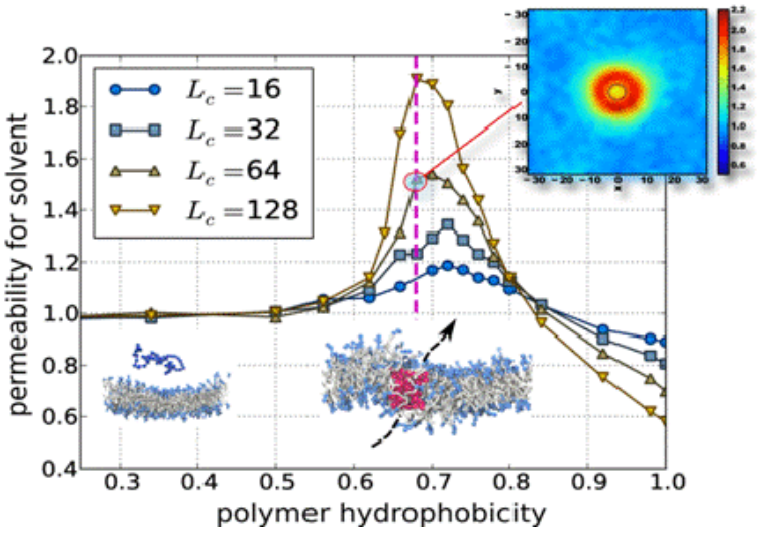

Fig. 1: Solvent permeability of a membrane patch (of radius 15 lattice units) around a polymer relative to the permeability of an unperturbed membrane as function of polymer hydrophobicity (chain length LC). The inset shows the solvent permeability in topview of the membrane as function of the distance to a polymer with hydrophobicity close to the adsorption threshold.

Amphiphilic polymer structures may translocate into mammalian cells by passive transport [1] and increase permeability for smaller molecules such as small sugars [2]. They are therefore promising candidates to optimize future applications such as cell-reprogramming or cryopreservation of blood. However, the physical mechanisms of polymer translocation and bilayer permeabilization remain unresolved up to now. We use a dynamic Monte Carlo simulation method to investigate the membrane-activity of single homo-polymer chains as function of their hydrophobicity on a coarse-grained level. Our simulation results suggest that there is a critical value of polymer hydrophobicity, where the polymer chain gets adsorbed at the bilayer interface [3]. This adsorption transition takes place, where effectively the solvent and the hydrophobic bilayer core are equally repulsive for the polymer and both environments act as poor solvents for the polymer. Therefore, the lipid tails are still incompatible for the fluctuating polymer chain close to the transition point, and a translocating polymer chain induces significant dynamic and static perturbations in the bilayer structure as well as an increased permeability with respect to solvent (see Fig. 1).

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