PhD project

3 years

Connecting the bulk and interface membrane properties of microbial glycolipid amphiphiles

The topic

Glycolipids are abundant constituents of biological membranes, where they are known to be involved in lipid lateral phase separation resulting, for example, in a local enrichment of membrane-anchored proteins, preferential membrane budding or selective ion attractivity.[1] However, glycolipids are complex molecules, generally synthesized in small amounts through a tedious organic chemistry process. Alternatively, microbial glycolipids (MG) are exclusively obtained from microbial fermentation of glucose and vegetable oils. Known in the literature under the name of *biosurfactants*, MG represent the future of amphiphiles for the low impact of their synthesis process, low toxicity, biodegradability and functionality.[2,3] Unfortunately, poor knowledge of their physico-chemical properties, have prevented further development, so far. Nonetheless, companies like Evonik, Dow chemicals and BASF[4] start to invest in MG since 2021 at an industrial scale, opening more and more perspectives. Ongoing research worlwide[5] show that MG self-assemble in water and at interfaces, with a complex phase behaviour.

One understudied aspect of MG is their ability to form monolayer vesicles (Figure 1a,b) and flat membranes.[6] Few existing works have shown interesting macroscale properties and potential applications. Flat membranes are colloidally stable and form lamellar hydrogels, supported dried monolayers can be prepared with high homogeneity from the *nm* to the *cm*-scale (Figure 1d) and multilamellar vesicles (Figure 1c) can encapsulate and deliver hydrophobic compounds through biological membranes. From a more fundamental standpoint, neutron spin echo shows that the membrane bending rigidity can vary of two orders of magnitude for structurally-similar molecules.

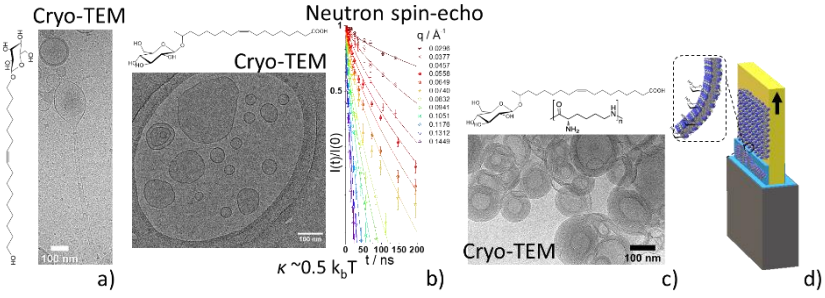

Figure 1 – Free-standing and supported membranes from various MG. a) Vesicle-nanotube networks; b) Unilamellar vesicles and related NSE experiment to evaluate the bending modulus; c) Multilamellar wall vesicles; d) Supported flat

Within this framework, this PhD position aims at studying the bulk (water) and interface (air-water) properties of MG using neutron scattering techniques (small angle neutron scattering -SANS- , neutron spin echo -NSE-, neutron reflectometry -NR-), provided the synthesis and purification of selectively deuterated MG.

---

[1] T. Mukhina *et al*., Phase behavior and miscibility in lipid monolayers containing glycolipids, *J. Coll. Inter. Sci*., **2022**, 615, 786

[2] Marchant *et al.* Microbial biosurfactants: challenges and opportunities. *Trends Biotechnol*., **2012**, 558

[3] I. Banat *et al*. Microbial biosurfactants production, applications, future potential. *App. Microbiol. Biotechnol*., **2010**, 427

[4] Links to corporate sites of Evonik, BASF and DOW.

[5] N. Baccile, S. Abel *et al.* Self-Assembly, Interfacial Properties, Interactions with Macromolecules and Molecular Modeling and Simulation of Microbial Bio-Based Amphiphiles (Biosurfactants). A Tutorial Review. *Green Chem.* **2021**, 3842

[6] N. Baccile et al. pH-Driven Self-Assembly of Acidic Microbial Glycolipids. *Langmuir* **2016**, 6343

The PhD is supported by a joint ANR (MOWGLY) – ILL (PhD@ILL) funding scheme and will take place between the SMiLES Team at the Laboratoire de Chimie de la Matière Condensée de Paris at Sorbonne Université (20% time), Paris, and the ILL (80% time), Grenoble.

The candidate

The candidate must hold a Master 2 degree in materials chemistry, materials science, chemistry or physics or related disciplines. A genuine interest and pragmatic approach to science is required. Knowledge in the fields of lipids, surfactants and of physical characterization techniques like DSC, SAXS, SANS, rheology, surface tension, NMR are strongly appreciated. Experience in purification techniques and microbiology are a plus.

Additional information

The project involves a 36-months full-time contract with forecast starting date in Fall 2024. Gross salary is about 2100 €/month. The PhD will start and will be mainly located in Grenoble.

For more information, please contact:
Niki BACCILE
Laboratoire de Chimie de Matière Condensée de Paris (LCMCP)
Sorbonne Université
4, place Jussieu, 75005 Paris, France
niki.baccile@sorbonne-universite.fr

Ingo HOFFMANN, Nicolò PARACINI
Institut Laue-Langevin
71 Av. des Martyrs, 38000 Grenoble
hoffmann@ill.fr
paracini@ill.fr