Development of artificial amphiphiles featuring light-switching and fluorescent properties for modulation of membrane permeability

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Inspired by the ability of living cells to respond dynamically to external stimuli, researchers have increasingly focused on developing artificial systems capable of performing complex tasks in response to controllable triggers. Mimicking such cellular responsiveness offers promising opportunities for applications ranging from water depollution to targeted drug delivery. In particular, the incorporation of molecular switches and motors into lipid membranes can induce significant changes in membrane biophysics, enabling controllable supramolecular behaviour.[1]

In this work, azobenzene-based amphiphiles were synthesised and incorporated into the bilayers of Giant Unilamellar Vesicles (GUVs). Upon light-induced *E*→*Z* isomerisation of the azobenzene units, distinct supramolecular behaviours were observed by confocal microscopy. Irradiation triggered pronounced changes in vesicle shape and size, accompanied by increased membrane permeability. Notably, all observed effects were fully reversible upon cessation of irradiation.[2] Building on these findings, the system was further developed by introducing fluorescent functionality to the amphiphile scaffold. The final Nile red-based amphiphiles (Ex_{max} = 515 to 559; Em_{max} = 585 to 635 nm) enabled direct tracking of amphiphile incorporation into both Giant and Large Unilamellar Vesicles (GUVs and LUVs), facilitating investigations into membrane domain formation, supramolecular shape transitions, and cargo release behaviour.[3]

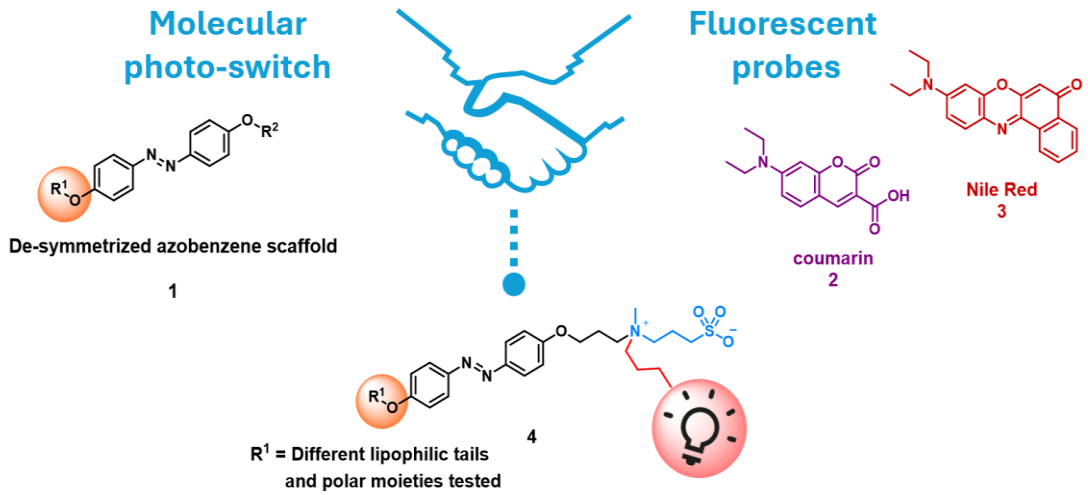

Figure: Schematic representation of the integration of photoswitchable azobenzene and fluorescent functionalities within the amphiphiles developed in this work

References:

[1] Guinart, A.; Doellerer, D. et al. *Langmuir,* **2025**, *41* (6), 3961–3970.

[2] Albanese, P.; Cataldini, S. et al. *Pharmaceutics,* **2022**, *14* (12), 2777.

[3] † Albanese, P.; † Cataldini, S. et al. *J. Mater. Chem. B,* **2026**, 14, 3093–3108.