Vesicle chemotaxis at the nanoscale: principles and applications.

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Abstract
Directional locomotion or taxis is possibly one of the most important evolutionary milestones, as it has enabled many living organisms to outperform their non-motile competitors [1]. In particular, chemotaxis (i.e. the movement of organisms either toward or away from specific chemicals) is the most common strategy adopted by many unicellular organisms to gather nutrients, escape toxins and help coordinate formation of colonies. Recently, we demonstrated that chemotaxis can be achieved by creating a nanoscopic vesicle loaded with enzymes, whose membrane have an asymmetric distribution of permeable domains [2]. When placed in the presence of a chemical gradient that act as substrate for the enzyme, the asymmetric distribution of flow across the vesicle membrane create a biased slip velocity around the vesicles and a consequent propulsion.
This, in turn, allows the vesicles to move chemotactically toward higher concentration of the substrate allowing long-ranged targeted delivery. Here, I will expand this concept using uniquely biological molecules with the final aim to demonstrate that a minimal organization of biomolecules can create the conditions for complex behavior such as chemotaxis. I will briefly present the physics associated with chemical gradient and how these create convective drifts and how these depend on both density gradient as well as diffusophoresis process associated with chemical interaction with wall surfaces.

References

[1] C. Nunes-Alves. Bacterial evolution: How to extend your stay. Nature Reviews Microbiology, 2016
[2] Joseph et al Science Advances 2017