Design of chemotactic nano-motors based on enzyme catalysis

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The movement of organisms in response to stimuli of different nature is a well-established phenomenon in nature. Bacteria, sperm cells and uni- or multicellular organisms are able to adapt themselves to environmental changes and translate by sensing external signals and adapting their motion towards or away from the sensed signals.[1] The stimuli, and the consequent generated motion that organisms experience, can be related to variations in the temperature (thermotaxis), magnetic field (magnetotaxis), adhesion forces (haptotaxis), and chemical gradient (chemotaxis).

The migration of cells towards chemical sources is a fundamental phenomena for many biological processes such as immune defense, wound healing and cancer metastasis.[2] Chemotaxis of cancer cells is thought to promote cancer metastasis, for example melanoma cells are directed out from tumors towards higher levels of a chemoattractant- lysophosphatidic acid in order for the cells to intravasate into local blood vessels.[3] However, the role of chemotaxis in the mechanisms of cellular vesicular transport is still relatively unexplored and poorly understood. Vesicular transport plays a central role in the traffic of molecules between different membrane-enclosed compartments rending it a major cellular activity.[4]

The main purpose of the present study is to explore the role of chemotaxis on vesicles transport and, particularly, elucidate the mechanisms of particles migration. Lipid nano-vesicles (liposomes) have been chosen as simple model vesicles with the aim of mimicking and reproducing the biological compartments that are involved in these cellular processes. The encapsulation and confinement of catalytically active biomolecules e.g. enzymes, within liposomes allows to investigate the liposomes response to various concentration gradients of specific substrates under a *self-diffusiophoretic* regime. To this aim, a film rehydration approach has been carried out in order to encapsulate glucose oxidase within 100 nm phosphatidylcholine-based liposomes. The motion experienced by empty and enzyme-encapsulated liposomes in presence of chemical gradients has been investigated by tracking and analysing singular particles trajectories over time and space.

Understanding the behaviour of the modelled system will significantly improve the design of self-propelling nano-devices with the ability of performing challenging tasks such as selective transport and site targeting within cellular environment.

References

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