ECOLE POLYTECHNIQUE DE BRUXELLES

TIPs

TIPs-µfluidics

Prof. B. Scheid

Experimental and modelling study to elucidate the dynamics of emulsification within mixing apparatuses for nanoparticle applications

https://www.precisionnanosystems.com/resources-and-community/knowledge-center/articles/detail/nxgen-technology-for-scaling-nanoparticle-production

Abstract: Emulsification is a critical process in pharmaceutical manufacturing, especially in the context of vaccine formulation. The manufacturing environment poses considerable challenges, necessitating rigorous conditions to ensure product integrity. This project proposes to investigate enhancements to the vaccine formulation process within the industry by employing process intensification techniques. The master thesis will be realized in collaboration with GSK vaccines (Rixensart). The research will be two-pronged: it will involve experimental work to elucidate the dynamics of emulsification within mixing apparatuses, and theoretical analysis to explore the fundamental principles underpinning the process. To achieve this, we will leverage modeling tools, with a particular emphasis on Computational Fluid Dynamics (CFD). This dual approach aims to optimize the emulsification process, thereby improving the quality and efficacy of vaccines while potentially reducing production costs and environmental footprint. The master student will provide an invaluable platform to contribute to impactful research that could significantly advance public health outcomes.

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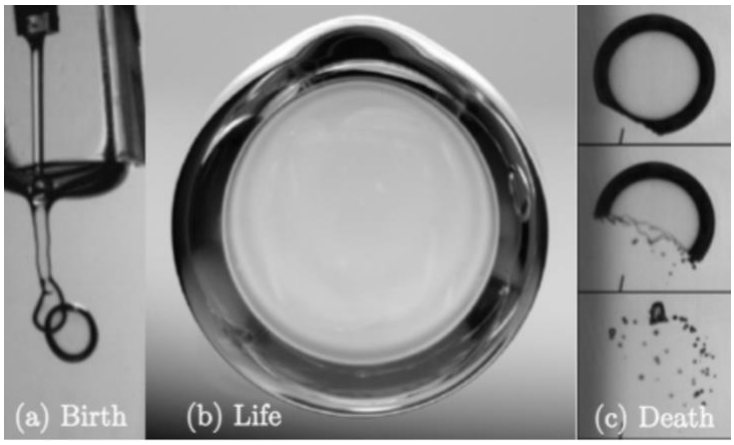
Oil-free encapsulation using microfluidic antibubbles

Summary: An emerging breakthrough in microfluidics is the formation of antibubbles (= a drop inside a bubble in a liquid). Antibubbles turn out to be a potential new elementary component in microfluidics (beside bubbles and droplets) with unequalled properties, combining those of bubbles and droplets, such as “flash” release of a disperse phase into a continuous one or contact-free all-aqueous emulsification (in the context of CO2 sequestration or protein encapsulation). Nevertheless, despite the current knowledge on antibubble dynamics two limitations prevent the antibubble to be used at the scale of a microfluidic process: the limited lifetime and the automated production in microfluidics. The master thesis will contribute to produce and manipulate micro-antibubbles by designing dedicated micronozzles using the nanoscribe 3D printer.



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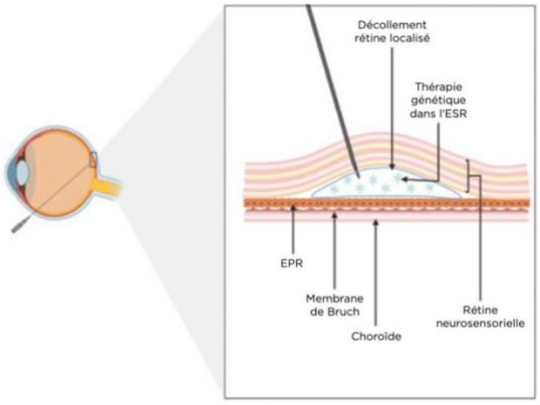
Experimental and theoretical modeling of subretinal injections

Abstract: For the production of therapeutic proteins in the posterior segment of the eyeball, gene therapy is the theoretically ideal option. The gene encoding the protein is introduced locally into cells which become endogenous internal bioreactors capable of producing it in situ [1]. The injection operation is shown in [2]. This operation is extremely delicate and requires automating the injection of the liquid containing the viral vectors. To do this, it is a question of optimizing this injection in particular to avoid damaging the cells of the retinal pigment epithelium (RPE) and avoid the reflux after injection.



The objective of the master thesis will be to model the injection under artificial retina in a set-up built in the lab and to identify the best pressure-control injection method to allow ophtalmologists to improve the surgical protocol. The master thesis will be performed in collaboration with ophtalmologists and possible test on animals (pigs).

The work will be essentially experimental, but with some mathematical and numerical modeling of the process for understanding and optimization purposes.

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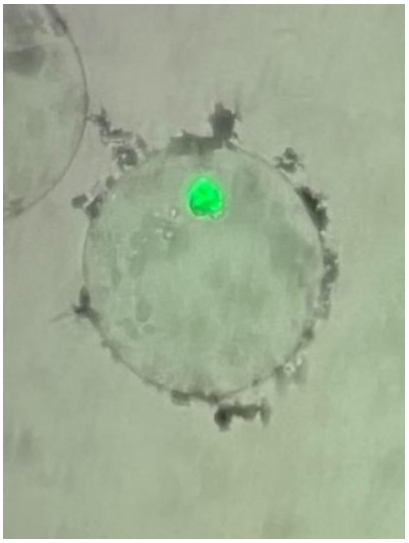
[1] https://www.em-consulte.com/em/SFO/2016/html/file_100018.html

[2] https://issuu.com/aoq-/docs/24959-aoq-revue-mars_avril_2023-web

Encaspulation of organoids



The project aims to develop a protocol for microencapsulating organoids in gel matrices in order to standardize their production and study the influence of matrix viscoelasticity on the development of a large number of organoids (healthy and tumorous). The mechanical properties of a specific set of encapsulated organoids will be studied in situ by applying mechanical deformations under living conditions. Organoids currently represent a recognized alternative to animal experimentation. The standardization of studies on a large number of organoids (several thousand) through the use of microfluidic tools should therefore have a significant impact on the industrial sector, which supplies research laboratories in particular. This work will be in collaboration with the « Institut de Recherche Interdisciplinaire en Biologie Humaine et Moléculaire (IRIBHM Jacques E. Dumont)" in the faculty of medicine at Erasme.

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