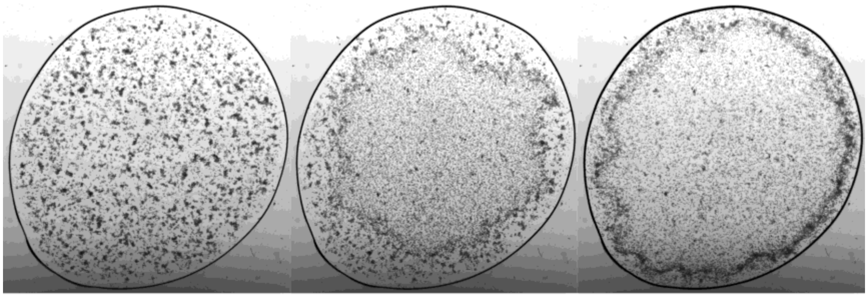
Master 1/2 internship proposal at Laboratoire Jean Perrin – LJP



t = 3 min t = 12 min t = 33 min

Aggregation dynamics of dense suspensions of paramecia and chemotaxis

Paramecium is a large unicellular eukaryote organism (100 – 300 µm long) that swims in fresh water by beating its cilia along "straight" helicoidal paths interrupted by reorientation events called avoiding reactions (AR) [1,2]. The AR can occur spontaneously or in response to different types of stimuli, like local variations of the concentration of ions/chemicals or mechanical interactions with obstacles, resulting in a diffusive-like motion at long times.

In past years, we studied the swimming behavior of individual paramecia in free and crowded environments, by developing an integrative model of the paramecium response [1] and by evidencing different types of ARs against micro-engineered obstacles [3]. Recently, we started to investigate the collective behavior of large assemblies of paramecia that are packed in an aqueous droplet confined between two horizontal plates, with the initial motivation to study how the mechanosensitive AR could modulate paramecia collective response in dense populations. We evidenced that, starting from a homogeneous suspension, paramecia would first cluster into small aggregates, that persist for a few minutes (*see* Figure above at t=3 min), before rapidly dissolving in the form of a density front that propagates outwards to the edge of the droplet (*see* Figure above at t=12 min and t=33 min).

It is unclear how these various self-organized structures emerge and what sets their size and dynamics. Since 1900, it has been known that paramecia can display a chemotactic behavior and be attracted or repelled by various types of substances [2] such as a weak acid solution or an alkaline solution respectively. One hypothesis for the cluster formation is thus that as paramecia breathe, they release $C0_2$ in their vicinity, that locally decreases the pH of the medium, that in turn acts as an attractant source.

To test this idea, the student will design an experiment to track the trajectories of paramecia swimming in a controlled linear pH gradient. The gradient will be made within a flat glass capillary with both ends connected to solutions with different pH, and comparison between wild type *Paramecium Tetraurelia* and its mutant *Pawn* that does not perform any AR will be made.

So far, the chemotactic behavior of paramecia has only been evidenced based on the observation of an accumulation of paramecia in a test solution relative to a control solution [4]. But no quantitative analysis of how paramecia can detect concentration or pH gradients, using either linear or logarithmic sensing for instance, has been performed and no confrontation to existing models of chemotaxis has been done. Beyond providing a driving mechanism for the initial clustering we observe, these experiments will shed light on these last questions.

References

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[2] R. Brette, *eNeuro* **8** (2021).
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[4] V. Leick, J. Helle, *Anal. Biochem.* **135**, 466 (1983); M. S. Valentine, J. L. Van Houten, *Methods Mol. Biol.* **1454**, 149 (2016).

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