Chemotactic interactions drive migration of membraneless active droplets

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In nature, chemotactic interactions are ubiquitous and play a critical role in driving the collective behaviour of living organisms. Reproducing these interactions *in vitro* is still a paramount challenge due to the complexity of mimicking and controlling cellular features, such as metabolic density, cytosolic macromolecular crowding and cellular migration, on a microorganism size scale. Here, we generate enzymatically-active cell-size droplets able to move freely and, by following a chemical gradient, able to interact with the surrounding droplets in a collective manner. The enzyme within the droplets generates a pH gradient that extends outside the edge of the droplets. We discovered that the external pH gradient triggers droplet migration and controls its directionality, which is selectively towards the neighbouring droplets. Hence, by changing the enzyme activity inside the droplet we tuned the droplet migration speed. Further, we showed that these cellular-like features can facilitate the reconstitution of a simple and linear protometabolic pathway with improved overall activity. Our work suggests that simple and stable membraneless droplets can be applied to reproduce complex biological phenomena opening new perspectives as bioinspired materials and synthetic biology tools.

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