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seminar

Thursday, 27th February, 12.00 pm, Seminar Room

Host: Prof. Luis Liz-Marzán

Sperm-based microbots and their potential to improve ART success and reproductive health

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Medical hybrid microbiorobots driven by powerful microorganisms (e.g. bacteria) or motile cells (e.g. sperm cells) represent a promising approach to perform non-invasive medical tasks in living organisms, such as local diagnosis and therapy. They combine the advantages of biological components (e.g. self-guidance mechanisms, ability to move in physiological environments and the possibility to load them with different cargoes), with the functionality of engineered microparts (e.g. imaging, cargo-delivery, micromanipulation) [1]. To this end, our group has developed medical microbots to assist sperm with motion deficiencies to reach the oocyte towards the treatment of two of the most common male infertility problems: oligospermia - low sperm count, and asthenospermia - low sperm motility, envisioning them for future in vivo assisted fertilization [2]. We have proven the potential to guide motile sperm with a magnetic microtube by aligning it along an external magnetic field [3]. Sperm release was also possible using a rolled-up thermoresponsive polymeric microtube, operating at physiological conditions [4]. Moreover, we reported the use of helical micro-carriers, driven by an external magnetic field to transport and release functional but immotile sperm cells [5]. However, there are still major challenges to be overcome before applying this technology in living organisms. First, the identification of the most fertile sperm, the transportation of multiple sperms to improve the fertilization rate, and the tracking of them in vivo with high spatio-temporal resolution, among others [5]. We also utilized this sperm-hybrid system towards gynecological cancer treatment, by loading sperm and its synthetic component with anti-cancer drugs [6,7]. To summarize, sperm-based microbots represent a biocompatible platform to transport cellular or molecular cargo to improve reproductive health either by assisting in oocyte fertilization or by delivering drugs to treat cancer tissue, both envisioned for in-vivo scenarios.

References

[1] L. Schwarz, M. Medina-Sánchez, and O. G. Schmidt. Applied Physics Reviews 4 (3), 031301 (2017)
[2] V Magdanz, M. Medina-Sánchez, L. Schwarz, H. Xu, J. Elgeti, O. G. Schmidt. Advanced Materials 29 (24), 1606301(2017)
[3] V. Magdanz, S. Sanchez, O.G. Schmidt, Advanced Materials, 25(45), 6581-6588 (2013)
[4] M. Medina-Sánchez, L. Schwarz, A.K. Meyer, F. Hebenstreit, O.G Schmidt, NanoLetters, 16(1), 555-561 (2015)
[5] M. Medina-Sánchez and O.G. Schmidt, Nature, 545(7655), 406-408 (2017)
[6] H. Xu, M. Medina-Sánchez, V. Magdanz, L. Schwarz, F. Hebenstreit, O.G Schmidt, ACS Nano, 12(1), 327-337 (2017)
[7] H. Xu, M. Medina-Sánchez, D. R. Brison, R. J. Edmondson, S. S. Taylor, L. Nelson, K. Zeng, S. Bagley, C. Ribeiro, L. P. Restrepo, E. Lucena, C. K. Schmidt, O.G. Schmidt. arXiv preprint arXiv:1904.12684 (2019)