Biomedical applications of sperm-hybrid micromotors

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Among the various reported medical microrobots, those based on physical and biological propulsion are promising for various biomedical tasks in living organisms. In particular the ones based on motile cells or microorganisms possess the ability to swim efficiently in complex environments, interacting with other biological tissues, and performing a variety of functions. Moreover, by incorporating engineered microparts to those biological components, it is possible to create unique medical tools capable of performing theragnostic operations non-invasively. Such microparts could be designed for instance to perform micromanipulation, local sensing, to enhance imaging contrast, or can be combined with already medically-approved nanomedicines for combinatory and targeted therapy.

In particular, our group have developed different types of such physical and biohybrid micromotors. We have successfully demonstrated the guidance and transport of motile and immotile sperm by magnetic microcarriers, actuated by weak external magnetic fields, in vitro, employing biological-relevant fluids. These sperm-hybrid microrobots have also been used as drug carriers towards gynecological cancer treatment. Moreover, we succeeded in the transport and release of multiple viable and mature sperm, being a crucial step to achieve the egg fertilization in vivo or to control drug dose in the case of cancer therapy. We have also evaluated their performance under blood stream and exploited their cargo-delivery functionality by functionalizing the carriers with heparin-loaded nanoliposomes. Finally, in order to translate these technologies to pre-clinical trials, we have reported the successful tracking of magnetically-driven micromotors in phantom, ex-vivo and in living mice with high spatial and temporal resolution employing ultrasound and photoacoustic imaging.

References

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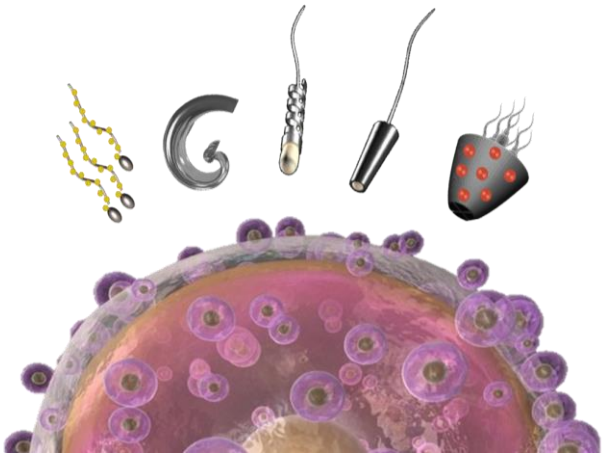

Figures

Figure 1. Sperm-based micromotors for gynecological healthcare applicaitons