IRONSperm: Sperm-templated flexible magnetic microrobots

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Biohybrid magnetic microrobots, referred to as IRONSperms, were developed by electrostatic-based self-assembly of non-motile sperm cells and magnetic nanoparticles (Figure 1). Such microrobots are under 100 µm in length and have potential unique applications for therapy and diagnosis in healthcare. IRONSperms consist of a cellular template (bovine sperm cell) with magnetic constituents (maghemite nanoparticles). Incorporating a biological entity into microrobots entails many functional advantages beyond shape templating, such as the facile uptake of DNA, RNA or chemotherapeutic agents to achieve targeted drug delivery. A single-step electrostatic-based self-assembly technique is presented to fabricate IRONSperms, which results in soft magnetic swimmers emulating the motion of motile sperm cells.[1] IRONSperms are actuated by external rotating magnetic fields and we observe out-of-plane wobbling of the head and helical wave propagation along the passive flagellum. It is also demonstrated that the nanoparticle coating increases the acoustic impedance of the sperm cells and enables localization of clusters of IRONSperm using ultrasound feedback.[2] Finally, cytotoxicity tests show the biocompatibility of IRONSperms and the drug delivery capability is demonstrated by loading their organic body with a model anti-cancer drug. This work presents new insights into the development of a biocompatible, controllable, and detectable biohybrid magnetic microrobot for in vivo targeted therapy.

REFERENCES

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[2] V. Magdanz, I. S. M. Khalil, J. Simmchen, G. P. Furtado, S. Mohanty, J. Gebauer, H. Xu, A. Klingner, A. Aziz, M. Medina-Sánchez, O. G. Schmidt, S. Misra, *Sci. Adv.* **2020**.

FIGURES

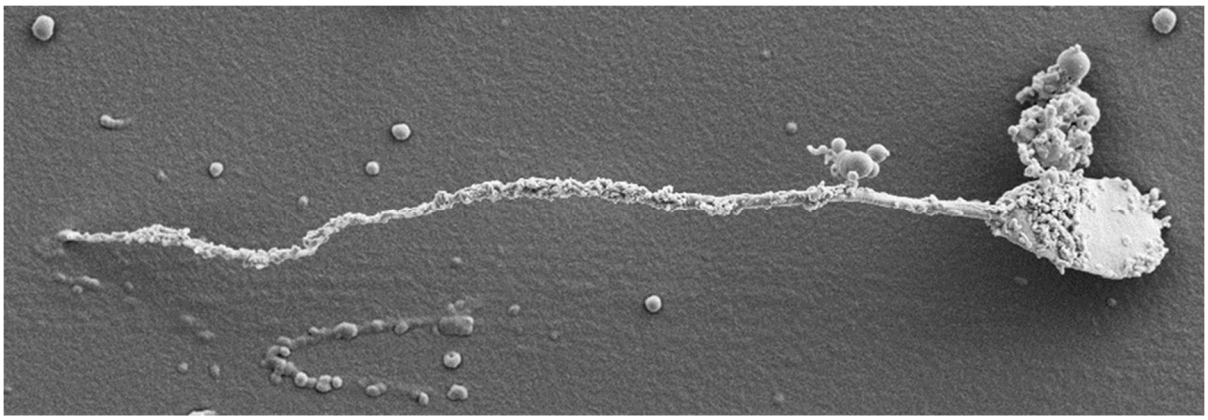

Figure 1: Bovine sperm cell with attached maghemite nanoparticles to create a sperm-templated flexible magnetic microrobot.