

Survey on Small Scale Technology for BME

Introduction

Micron and nano scale technologies are of interest because they allow for engineering opportunities and abstractions that require many small components to be actualized. For example, the average human neuron is on the order of tens of microns [1, 2]. This makes the design of neural interfaces more complicated because small objects form deeply connected networks. DNA and other biological structures exist at nanometer scale [3].

Artificial Organelles

Artificial Organelles have the ability to improve certain functionalities within a cell [4]. The study of artificial organelles may be useful for understanding how to design sophisticated biomedical technologies that operate at the cellular level.

References:

1. Shapson-Coe A, Januszewski M, Berger DR, et al. A petavoxel fragment of human cerebral cortex reconstructed at nanoscale resolution. *Science*. 2024;384(6696):eadk4858. doi:10.1126/science.adk4858
2. Yang W, Yuste R. Brain maps at the nanoscale. *Nat Biotechnol*. 2019 Apr;37(4):378-380. doi: 10.1038/s41587-019-0078-2. PMID: 30872818; PMCID: PMC7053416.
3. Alberts B, Johnson A, Lewis J, et al. *Molecular Biology of the Cell*. 4th edition. New York: Garland Science; 2002. Chromosomal DNA and Its Packaging in the Chromatin Fiber. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK26834/>
4. Wang, J., Zhao, M., Wang, M. *et al*. Human neural stem cell-derived artificial organelles to improve oxidative phosphorylation. *Nat Commun* 15, 7855 (2024). <https://doi.org/10.1038/s41467-024-52171-2>
5. Oerlemans, R.a.J.F.; Timmermans, S.B.P.E.; Van Hest, J.C.M. Artificial organelles: Towards adding or restoring intracellular activity. *ChemBioChem* 2021, 22, 2051–2078.
6. Santinho, A., Carpentier, M., Lopes Sampaio, J. *et al*. Giant organelle vesicles to uncover intracellular membrane mechanics and plasticity. *Nat Commun* 15, 3767 (2024). <https://doi.org/10.1038/s41467-024-48086-7>
7. Tian, F., Zhou, Y., Ma, Z., Tang, R., & Wang, X. (2024). Organismal Function Enhancement through Biomaterial Intervention. *Nanomaterials*, 14(4), 377. <https://doi.org/10.3390/nano14040377>

8. I. Gispert, J.W. Hindley, C.P. Pilkington, H. Shree, L.M.C. Barter, O. Ces, Y. Elani, Stimuli-responsive vesicles as distributed artificial organelles for bacterial activation, *Proc. Natl. Acad. Sci. U.S.A.* 119 (42) e2206563119, <https://doi.org/10.1073/pnas.2206563119> (2022).
9. Kolb HC, Finn MG, Sharpless KB. Click Chemistry: Diverse Chemical Function from a Few Good Reactions. *Angew Chem Int Ed Engl.* 2001;40(11):2004-2021. doi:10.1002/1521-3773(20010601)40:11<2004::AID-ANIE2004>3.0.CO;2-5
10. Scinto SL, Bilodeau DA, Hincapie R, et al. Bioorthogonal chemistry. *Nat Rev Methods Primers.* 2021;1:30. doi:10.1038/s43586-021-00028-z
11. Mitry, M. M., Greco, F., & Osborn, H. M. (2023). In vivo applications of bioorthogonal reactions: chemistry and targeting mechanisms. *Chemistry—A European Journal*, 29(20), e202203942.
12. Jiang, T., Henderson, J.M., Coote, K. et al. Chemical modifications of adenine base editor mRNA and guide RNA expand its application scope. *Nat Commun* 11, 1979 (2020). <https://doi.org/10.1038/s41467-020-15892-8>
13. Tu T, Song Z, Liu X, et al. A precise and efficient adenine base editor. *Mol Ther.* 2022;30(9):2933-2941. doi:10.1016/j.ymthe.2022.07.010