Intracellular pH modulation with a protonic biotransducer

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Protons (H^+) are essential for most physiological activities in organelles and cells. Proton transport across the cell membrane regulates intracellular processes of cell volume regulation, small molecule transport, and regulation of metabolic process. In this study, we have demonstrated a sulfonated polyaniline (SPA) biotransducer that can modulate the intracellular pH in adhesive C6 cells with the applied potential, which is directly coupled with proton to facilitate engineering interactions with physiological processes in the cells. To modulate pH in the buffer solution and the intracellular fluid, we improved the performance of SPA biotransducer by the coating of carbon nanotube supportive layer that provides high H^+ selectivity in the solution and also high H^+ capacity in the hybrid SPA electrode. The intracellular pH modulation was succeeded by the applied potential of below ±0.6 V. The modulated pH in the cells stimulated the mitochondrial membrane potential and intracellular Ca^{2+} concentration, while the PEDOT-based non-selective biotrasducer in the control experiment was insufficient for intracellular pH modulation. Therefore, the present biotransducer provides a new perspective to transfer a proton signal into the cells for modulating the functions (Fig. 1).

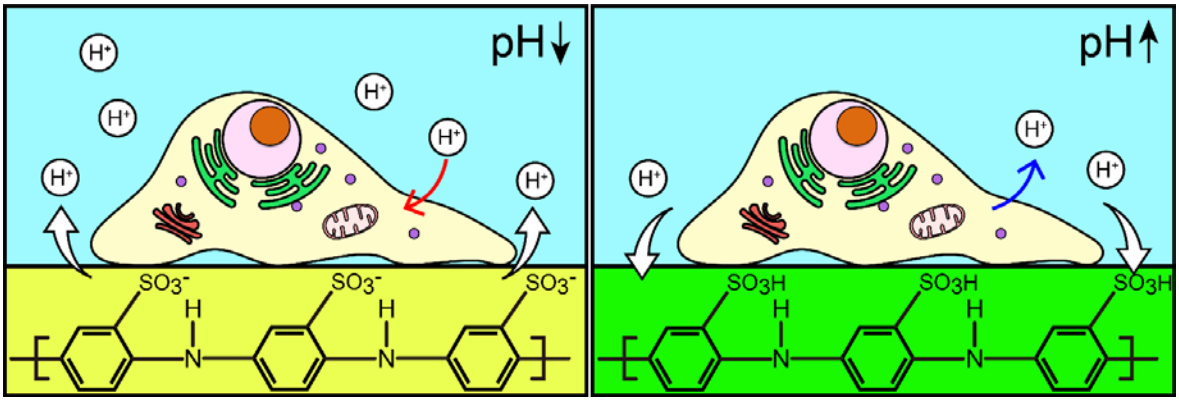

Fig. 1. Scheme of pH modulation in adhesive cells with protonic biotransducer.

Reference

1. Zhang Z, Kashiwagi H, Kimura S, Kong S, Ohta Y, Miyake T. A protonic biotransducer controlling mitochondrial ATP synthesis. Sci Rep. 2018 Jul 12;8(1):10423. doi: 10.1038/s41598-018-28435-5. PMID: 30002478; PMCID: PMC6043558.