A protonic biotrasducer controlling mitochondrial ATP synthesis

早大院情報生産 [1]，農工大 [2]，○(M1) 張子義 [1]，孔書毅 [1]，太田善浩 [2]，三宅丈雄 [1]
Waseda Univ. [1], Tokyo Univ Agri Tech. [2], °Ziyi Zhang[1], Shuyi Kong[1], Yoshihiro Ohta[2], Takeo Miyake[1]
E-mail: zzywaseda@ruri.waseda.jp

In nature, protons (H^+) play an important role in biological activities such as in mitochondrial ATP synthesis, which is driven by a H^+ gradient across the cell inner membrane, or in the activation of acid sensing ion channels in neuron cells. Bioprotonic devices directly interface with the H^+ concentration (pH) to facilitate engineered interactions with these biochemical processes. Here we demonstrate a H^+ biotransducer that changes the pH in a mitochondrial matrix by controlling the flow of H^+ between a conductive polymer of sulfonated polyaniline and solution. We have successfully modulated the rate of ATP synthesis in mitochondria by altering the solution pH (Fig.1).

To calibrate the H^+ biotransducer, we first investigate the dependence of the acceptance (doping) and donation (dedoping) of protons within the polymer structure on the potential applied to the SPA polymer. We could modulate pH reversibly and electrochemically on the vicinity of SPA electrode from 6.5 to 7.0 in 10 mM Tris-HCl buffer solution. We applied such pH modulation to mitochondrial applications. First, we integrate isolated mitochondria into our pH modulator and then confirmed that H^+ transfer at the SPA transducer induces the pH modulation within the mitochondrial matrix. Such mitochondrial pH modulation results in the control of ATP synthesis in mitochondria. In my presentation, I will discuss the detail about experimental results.

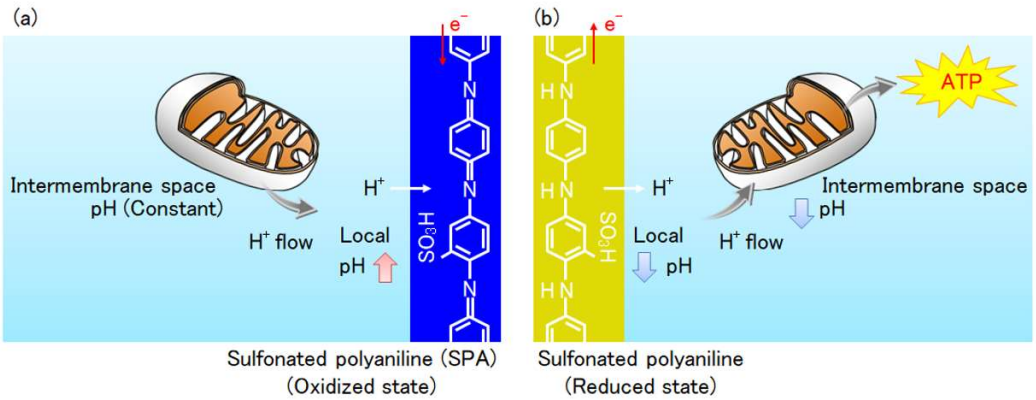

Figure 1. Bioprotonic transducer controlling ATP synthesis in mitochondria. (a) Proton-motive force (H^+ concentration in intermembrane space) reduces upon an applied negative potential to the SPA contact. (b) Proton-motive force enhanced upon an applied positive potential to the SPA contact, resulting in mitochondrial ATP synthesis.