Supporting Information

Porous Microneedle-Based Potentiometric Sensor for Intradermal Electrolyte Monitoring

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Materials and fabrication of MN chip containing porogen

A monomer stock solution consisting of a glycidyl methacrylate (10 mL, FUJIFILM Wako Pure Chemical Corporation, Ltd.), trimethylolpropane trimethacrylate (5.23 mL, Sigma-Aldrich Co.) and triethylene glycol dimethacrylate (15.7 mL, FUJIFILM Wako Pure Chemical Corporation, Ltd.) was prepared at 25 °C. A porogen stock solution consisting of a mixture of polyethylene glycol (4.0 g, FUJIFILM Wako Pure Chemical Corporation, Ltd.) and diethylene glycol monomethyl ether (20 mL, FUJIFILM Wako Pure Chemical Corporation, Ltd.) was prepared at 65 °C. The monomer and porogen stock solutions were mixed (11:9 in volume) at 40 °C with the addition of a photoinitiator (Irgacure 184; FUJIFILM Wako Pure Chemical Corporation, Ltd.). The precursor solution was poured into the female polydimethylsiloxane (PDMS) (SILPOT 184; Dow Corning Toray Co., Ltd.) mold, and degassing was performed under a vacuum of −0.096 MPa for 80 min to completely fill the microneedle-shaped cavities of the mold with the prepared solution. Photopolymerization under irradiation with 365 nm UV light (Model UVL-28; Funakoshi Co., Ltd.) was conducted for 3 h at 25 °C under a nitrogen atmosphere.

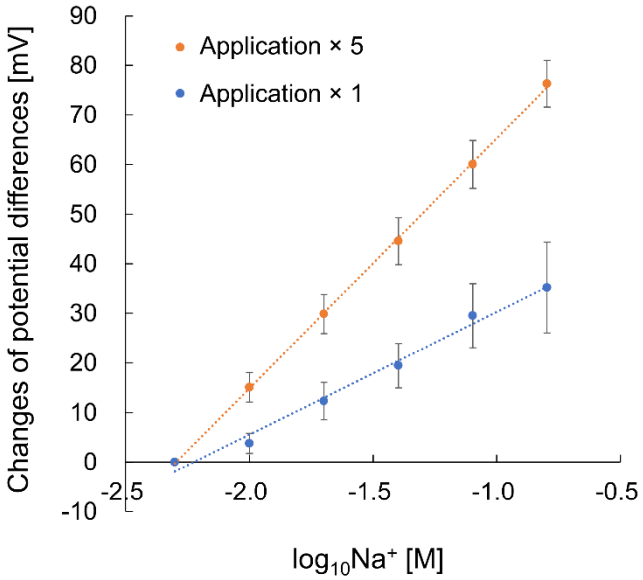

Fig. S1. Plots of potential differences of Pt electrodes with different numbers of Na^+ ISM solution applications (n = 3 independent experiments; mean ± SEM). For comparison, the potential difference at 5 mM is defined as 0 mV.

Biocompatibility evaluation of ion-selective PMN electrode

The Na^+ ISM/PMN electrode was sterilized using an autoclave and soaked in the medium for 24 h (Fig. S2a). Normal adult human dermal fibroblasts (3.8×10^4 cells/cm^2, NHDF-Ad, Lonza) were seeded to a 48-well dish and cultured for 24 h at 37 °C and 5 % CO_2, and subsequently, the supernatant was replaced with the medium soaked with the electrode (medium (+)). After three days of cell culture, the wells containing cells were washed twice with PBS, followed by treatment with the LIVE/DEAD™ Viability/Cytotoxicity Kit (Thermo Fisher Scientific). The fluorescence images were randomly captured using a fluorescence microscope for each well (Fig. S2b), and image analysis was performed using ImageJ software to determine the percentage of live/dead cells in each sample. As shown in Fig. S2c, the viability of the cells is as high as that of the control sample (medium (−)), which was cultured with a medium without presoaking the electrode.

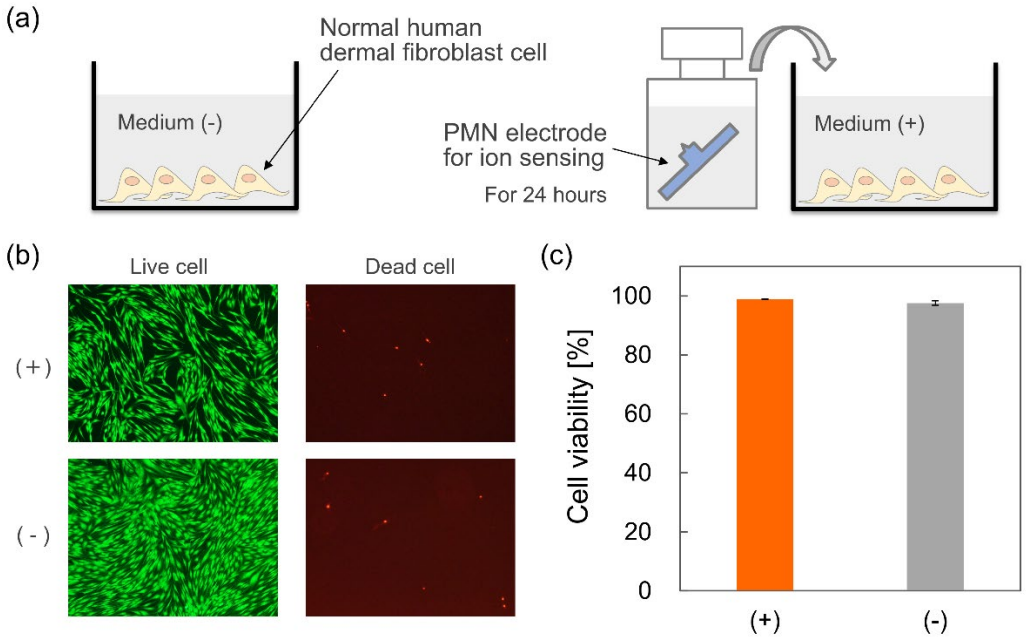

Fig. S2. (a) Schematic of normal adult human dermal fibroblasts (NHDF-Ad) seeded to a 48-well dish and cultured for 3 days in cell culture medium. (b) Live/dead staining of the cells cultured with the medium with (+) and without (−) presoaking the ion-selective PMN electrode for 24 h. (c) Cell viability derived from image analysis for the cases with (+) and without (−) presoaking the ion-selective PMN electrode (n = 3 independent experiments; mean ± SEM).

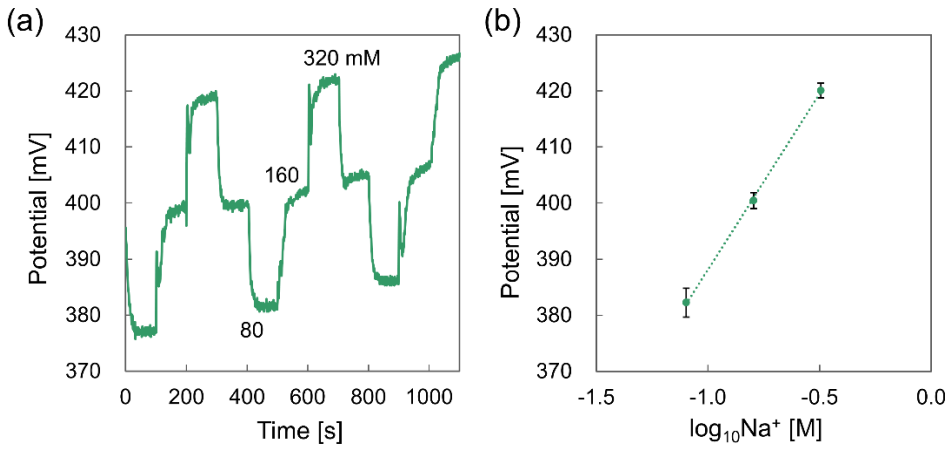

Fig. S3. (a) Potentiometric response and (b) calibration curve of the Na^+ ISM/PMN electrode to the NaCl solution after measurements using pig skin (n = 3 experiments; mean ± SEM).