Supporting Information

Electrolysis in aqueous solution

If a potential is applied between two electrodes in an aqueous solution electrolysis occurs. At the cathode H_2O (Reaction SI) is more easily reduced than sodium ions (Reaction SII), which is reflected in their different standard reduction potentials E° vs. normal hydrogen electrode (NHE). At the anode oxidation of Cl^- ions and H_2O molecules may occur.
Even though the oxidation of H_2O (Reaction SIII) is thermodynamically favored due to its lower standard reduction potential at equilibrium situation compared to chloride (Reaction SIV), chloride formation is kinetically favored (Swaddle, T.W., 1997.).

Reactions at the cathode in aqueous NaCl solution

(SI) $2\ H_2O + 2\ e^- \leftrightarrow H_2 + 2\ OH^-$ E°= -0.83 V vs. NHE

(SII) $Na^+ + 1\ e^- \leftrightarrow Na$ E°= -2.71 V vs. NHE

Reactions at the anode in aqueous NaCl solution

(SIII) $2\ H_2O \leftrightarrow O_2 + 4\ H^+ + 4\ e^-$ E°= 1.23 V vs. NHE

(SIV) $2\ Cl^- \leftrightarrow Cl_2 + 2\ e^-$ E°= 1.36 V vs. NHE

Standard curve for optical pH measurements

A standard curve was made to relate the fluorescence intensity of the indicator dye to the pH. Therefore phosphate citrate buffered pH standard solutions were made according to the mixing table proposed by McIlvaine with 0.2 M $Na_2HPO_4 \cdot 2H_2O$ and 0.1 M citric acid and the indicator dye mixture was added. The flow cell was then filled with these standard pH solutions and XY-plane images were taken 10µm above the surface of the substrate (Figure 1A). The fluorescent intensity was averaged over the entire image and the resulting fluorescence versus pH plot was fitted by a fifth order polynomial equation to obtain a standard curve (Figure S1).

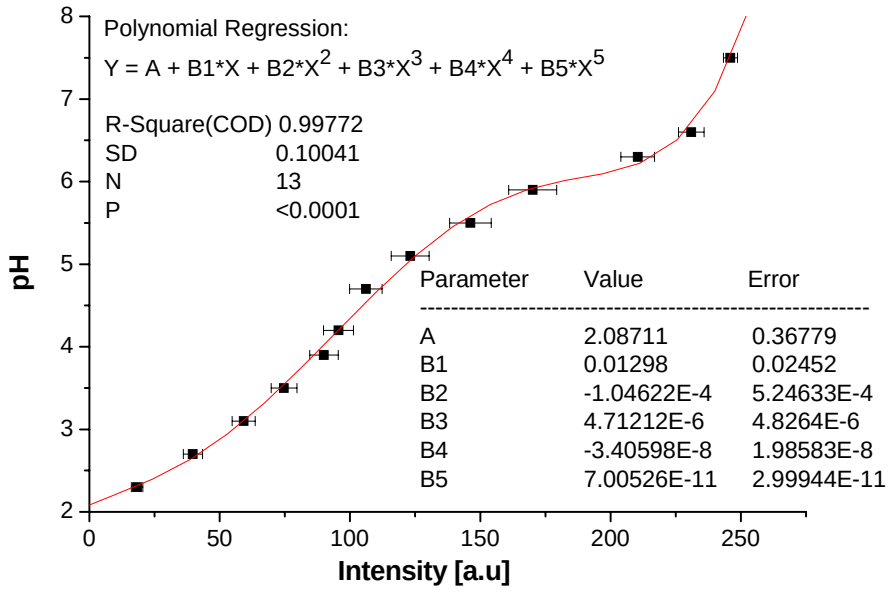

Figure S1: The plot shows the standard curve for the measured fluorescence intensity of the fluorescent dye mixture of 10µM carboxyeosin and 10µM fluorescein vs. pH. The indicator dye stock solution was therefore pipetted into

phosphate citrate buffered solutions and then all were measured with the same settings on a confocal laser scanning microscope.

Cell exposure to different pH solutions

A control experiment was performed in order to compare the observed effects of applied currents to cell behavior with the effect of cell exposure to different pH solutions. Therefore, different isotonic solutions were made by mixing H_2O and 1 M HCl, both with a physiological amount of NaCl (150 mM), to achieve solutions with pH between 1.2 and 7. M2C12 myoblasts were cultured for 24h in 24-well polystyrene dishes (NUNC™) prior to the cell experiment. Then the cells were exposed for 2 min to either the pure pH solutions or the pH solution containing 2.5 μg/ml propidium iodide. Then the cells were treated the same way as explained in the current experiment. The pH solutions with PI were directly incubated in PBS-PI for 20 min before fixation while the cells in pure pH solution had the chance to recover in growth media for 30 min before the PBS-PI incubation and fixation (Figure S2). After the formaldehyde fixation the cells were also stained with DAPI.

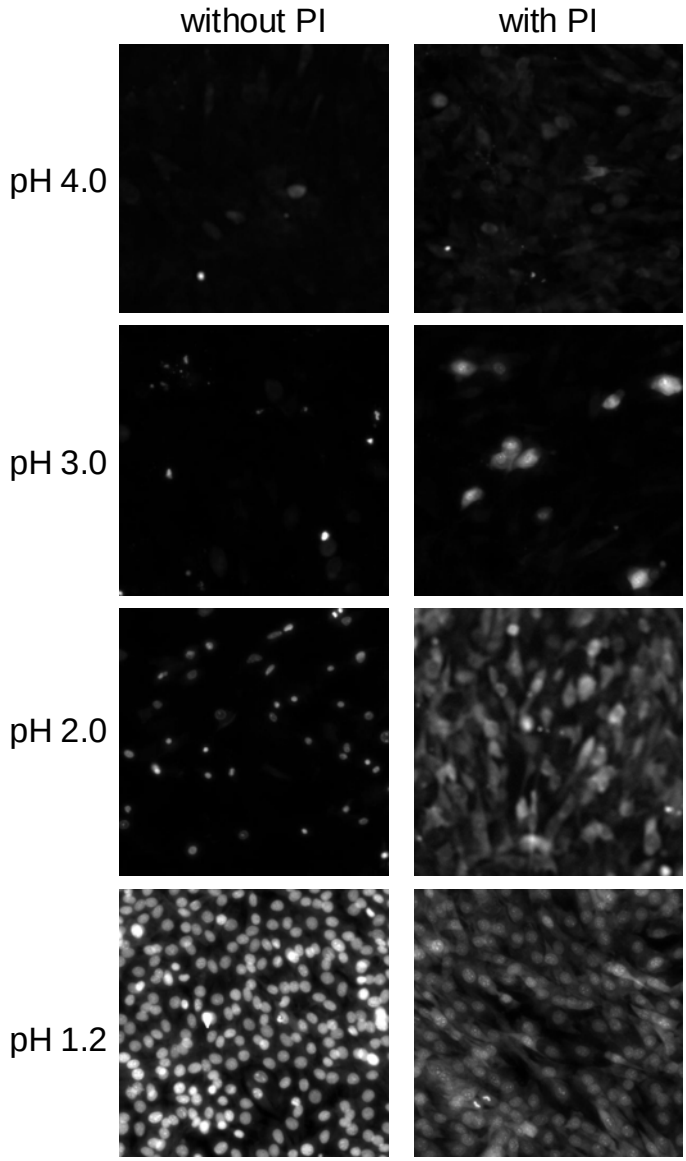

Figure S2: M2C12 myoblast were cultured in 24-well polystyrene dishes (NUNC™) prior to the experiment. Then the cells were exposed for 2 min to either the pure pH solutions or the pH solution containing propidium iodide. Afterwards the pH solutions with PI were exchanged to PBS-PI for 20 min before fixation. The cells in pure pH solution had the chance to recover in growth media for 30 min. The growth media was then changed to PBS-PI for 20 min before fixation. All images were taken with the same camera and microscope settings.

pH between cell and electrode

The pH between cell and electrode was calculated by a 2D finite element method (COMSOL, Multiphysics®) in the gap between a hypothetical surface attached cell (rectangular box 30x10 µm) and a flat electrode of the same size (30 µm). The gap between the cell and the electrode was assumed to be 100 nm. The finite element mesh size was refined and the end boundary of the free space was set far enough (1 mm) with diffusive boundary condition so the results did not depend on calculation condition. The calculation gave similar pH values for both parameter sets: pH 2.9 (I_{fit}=0.032 A/m^2, D_{fit}=3.3·10-10 m/s^2) and pH 3.2 (I_{real}=0.64 A/m^2, D_{Proton}=9.3·10-9 m/s^2). These pH values were reached already after 0.5 s and did not change during the simulated time of 2 min (Figure S3).

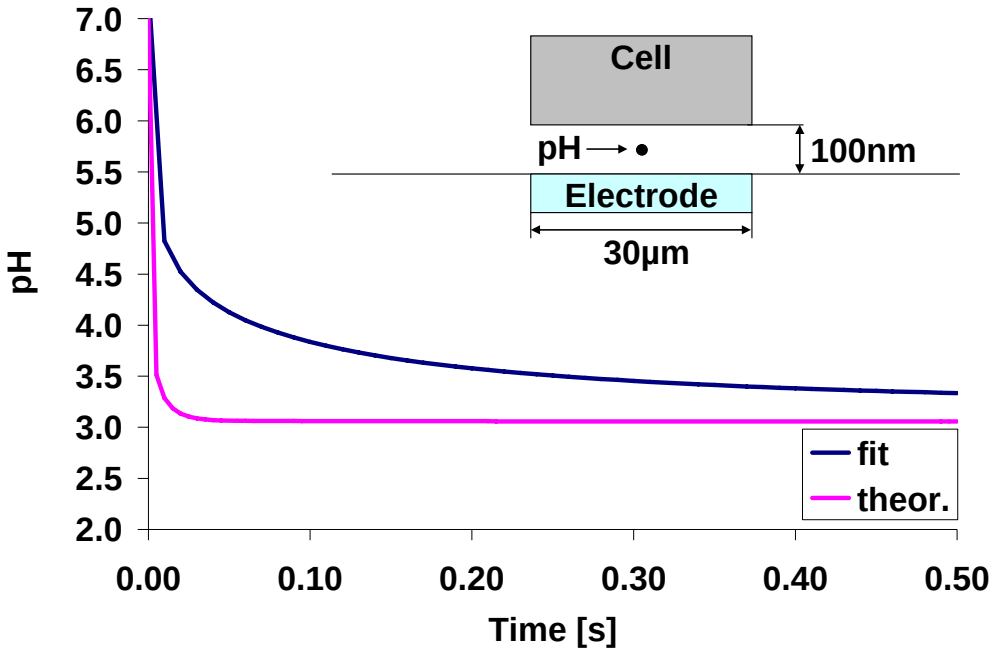

Figure S3: The pH between cell and electrode was calculated with a 2D finite element model. A rectangular hypothetical cell is positioned at a distance above the electrode. The time evolution of the calculated pH in the center of the gap is plotted for the first 0.5 s using the fitted parameters (I_{fit}, D_{fit}) and the theoretical parameters (I, D). A stable value of about pH3 is achieved independent of the used parameter sets.