Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Electrical cell-to-cell communication using the aggregate of model cells

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Figure SI-1 shows the liquid-membrane electrochemical cell. A PTFE porous membrane filter impregnated with the nitrobenzene (NB) solution was used as the liquid membrane. The membrane filter was set between two glass cells, and an O-ring was used to prevent leakage of water. The aqueous solutions containing electrolytes, as shown in schemes (1) and (2), were filled in two containers (W1 and W2).

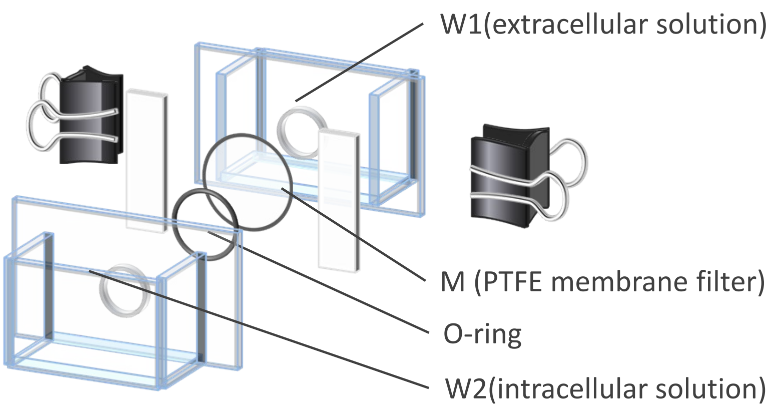
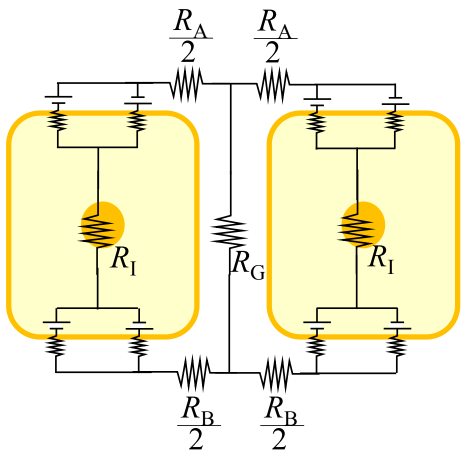


Fig. SI-1. The glass cell for K^+ or Na^+ channel mimicking cell.

(a)



(b)

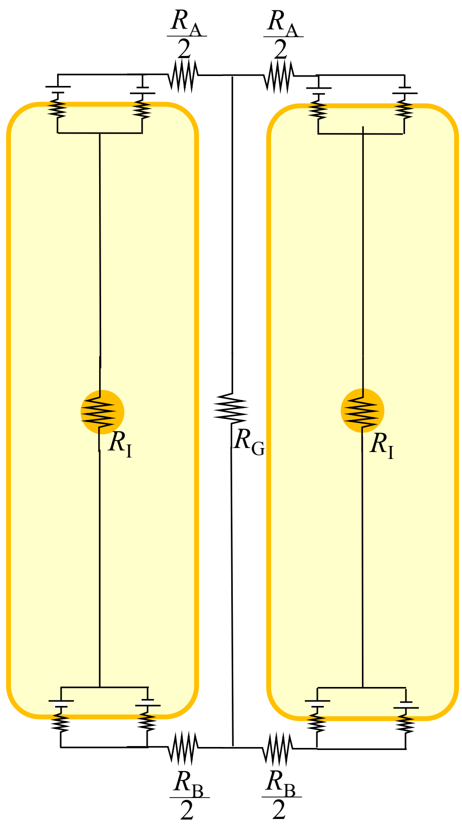


Fig. SI-2. Equivalent circuit for different types of cells

(a) Round cells scattered in electrolyte solution. R_A and R_B are large. R_G is small. (b) Slender cells packed closely, like muscle cells. R_A and R_B are small. R_G is large.

When cubic or spherical cells are scattered in an electrolyte solution, the electric resistances between adjacent two sites of two cells (R_A and R_B) is so large that the electric current hardly flows between two cells, as illustrated in Fig. SI-2a. Accordingly, the intercellular propagation of electric signal is practically impossible. In the case that the distance between two slender cells is very narrow, R_A and R_B are negligible small and the solution resistance of the gap (R_G) is large, as shown in Fig. SI-2b. When a circulating current due to the change of the membrane potential from the rest potential to the action potential is generated at one end of a certain slender cell, the change in the electric field spreads easily toward neighboring cells. Then, the electric signal can be propagated among multiple cells. Since the solution resistance (RI) of inside of the slender cell is also larger than that of the cubic or spherical cell, the transmission of the electric signal between two adjacent cells is liable to be facilitated.