生物物理学Ⅰ Handout No. 5

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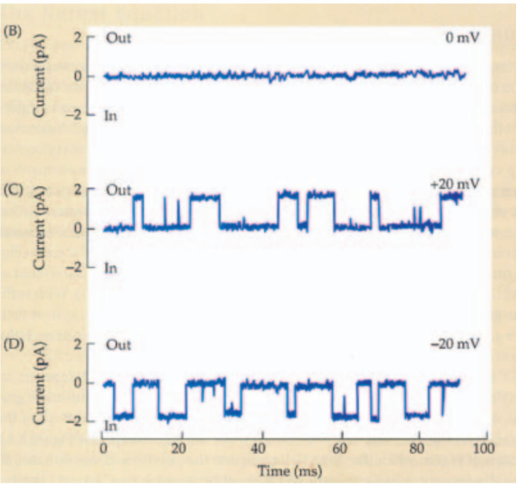

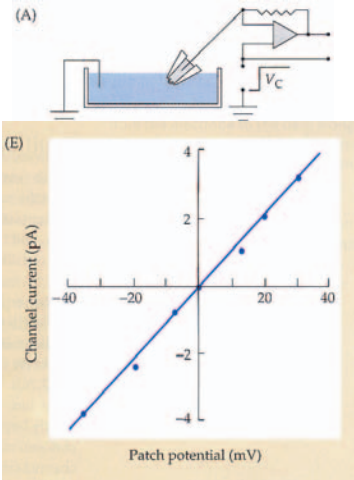

FIGURE 2.6 Effect of Potential on Currents through a single, spontaneously active potassium channel in an outside-out patch, with 150 mM potassium in both the electrode and the bathing solution. (A) The recording system. The output from the patch clamp amplifier is proportional to the current across the patch. The potential across the patch is equal to the potential (V_c) applied to the input of the amplifier as shown. Positive charge flowing out of the electrode is defined as positive current. (B) When no potential is applied to the patch, no channel currents are seen because there is no net flux of potassium through the channels. (C) Application of +20 mV to the electrode results in an outward current (upward deflections) of about 2 pA through the channels. (D) A -20 mV potential results in inward channel currents (downward deflections) of the same amplitude as in C. (E) Channel currents as a function of applied voltage. The slope of the line is the channel conductance (y). In this case, γ = 110 pS (picosiemens).

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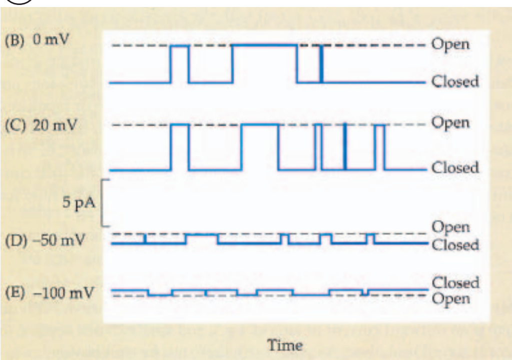

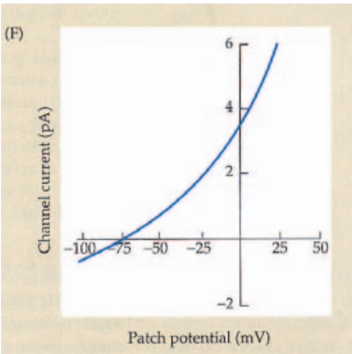

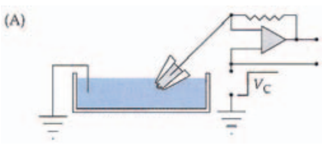

FIGURE 2.7 Reversal Potential for Potassium Currents in a hypothetical experiment using an outside-out patch with the concentration of potassium in the recording pipette ("intracellular" concentration) 90 mM and in the bathing solution ("extracellular" concentration) 3 mM. (A) Recording arrangement as in Figure 2.6. (B) With no potential applied to the pipette, the flux of potassium from the electrode to the bath along its concentration gradient produces outward channel currents. (C) When a potential of +20 mV is applied to the pipette, outward currents increase in amplitude. (D) Application of -50 mV to the pipette reduces outward currents. (E) At -100 mV, currents are reversed. (F) The current-voltage relation indicates zero current at -85 mV, which is the potassium equilibrium potential (E_K).

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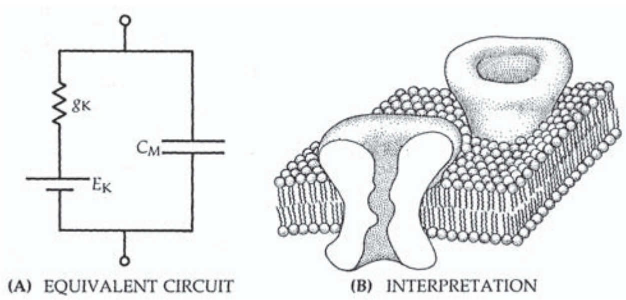

5 TWO VIEW OF A K^+-SELECTIVE MEMBRANE

In electrical experiments the membrane acts like an equivalent circuit with two branches. The conductive branch with an EMF of E_K suggensts a K^+-selective aqueous diffusion path, a pore. The capacitive branch suggests a thin insulator, the lipid bilayer.

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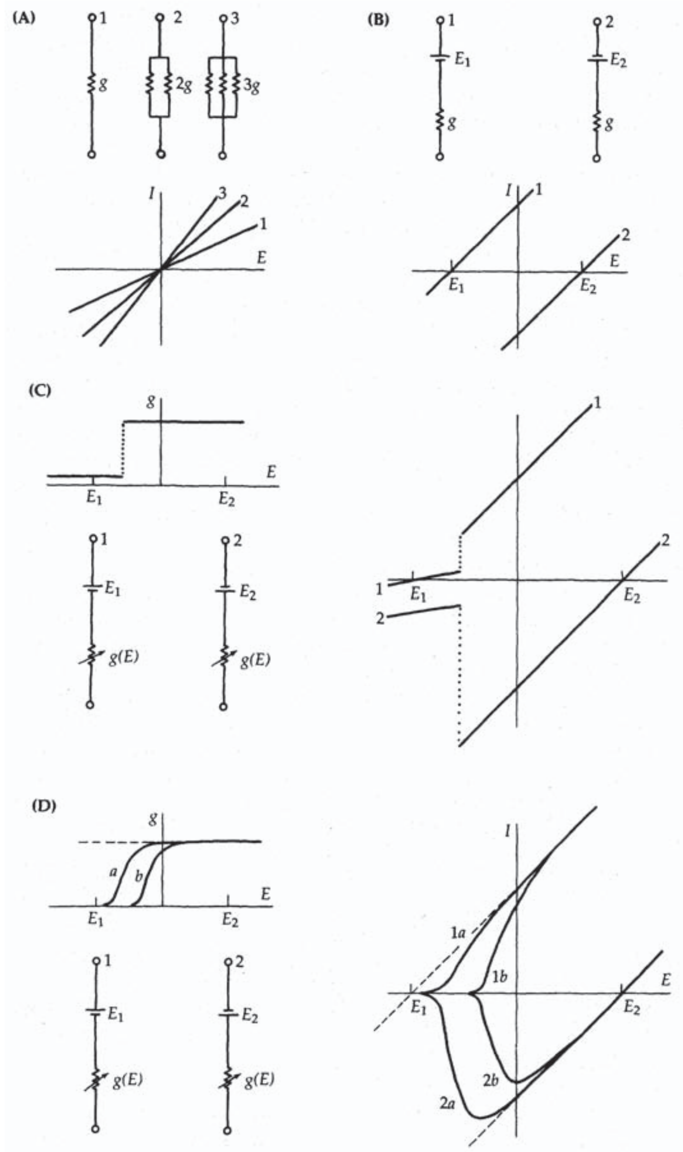

6 CURRENT-VOLTAGE RELATIONS OF MEMBRANES

Measured I-V relations can be interpreted in terms of electrical equivalent circuits and the modified form of ohm's law (Equation 1-12) that takes into account the electromotive force in the pores. Four hypothetical conditions are shown. (A) Membranes with 1, 2, and 3 pores open give I-V relations with relative slopes of 1, 2, and 3. (B) Pores with negative or positive electromotive farces give I-V relations with negative or positive zero-current potentials. (C) Pores that step from a low-conductance state to a high-conductance state (see inset graph of g versus E) give I-V relations consisting of two line segments. (D) Pores with smoothly voltage-dependent probability of being open (see inset graph of average g versus E} give curved I-V relations. The dashed lines, corresponding to a constant high conductance, are the same I-V relations as in part B. However, when the pores close at negative potentials, lowering g, the current decreases correspondingly from its maximal value.