# 生物物理学 I　Handout No. 3

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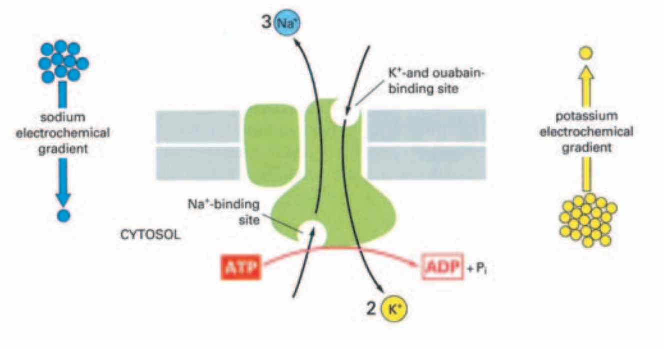


**Figure 11-10 The $Na^+$-$K^+$ ATPase.**
This carrier protein actively pumps $Na^+$ out of and $K^+$ into a ce11 against heir electrochemical gradients. For every molecule of ATP hydrolyzed inside the cell, three $Na^+$ are pumped out and two $K^+$ are pumped in. The specific pump inhibitor ouabain and $K^+$ compete for the same site on the external side of the ATPase.

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**Table 11–1 Comparison of Ion Concentrations Inside and Outside a Typical Mammalian Cell**

| Component | Intracellular Concentration (mM) | Extracellular Concentration (mM) |
|---|---|---|
| Cations | | |
| $Na^+$ | 5–15 | 145 |
| $K^+$ | 140 | 5 |
| $Mg^{2+}$ | 0.5 | 1–2 |
| $Ca^{2+}$ | $10^{-4}$ | 1–2 |
| $H^+$ | $7 \times 10^{-5}$ ($10^{-7.2}$ M or pH 7.2) | $4 \times 10^{-5}$ ($10^{-7.4}$ M or pH 7.4) |
| Anions* | | |
| $Cl^-$ | 5–15 | 110 |

*The cell must contain equal quantities of + and – charges (that is, be electrically neutral). Thus, in addition to $Cl^-$, the cell contains many other anions not listed in this table; in fact, most cellular constituents are negatively charged ($HCO_3^-$, $PO_4^{3-}$, proteins, nucleic acids, metabolites carrying phosphate and carboxyl groups, etc.). The concentrations of $Ca^{2+}$ and $Mg^{2+}$ given are for the free ions. There is a total of about 20 mM $Mg^{2+}$ and 1–2 mM $Ca^{2+}$ in cells, but this is mostly bound to proteins and other substances and, in the case of $Ca^{2+}$, stored within various organelles.

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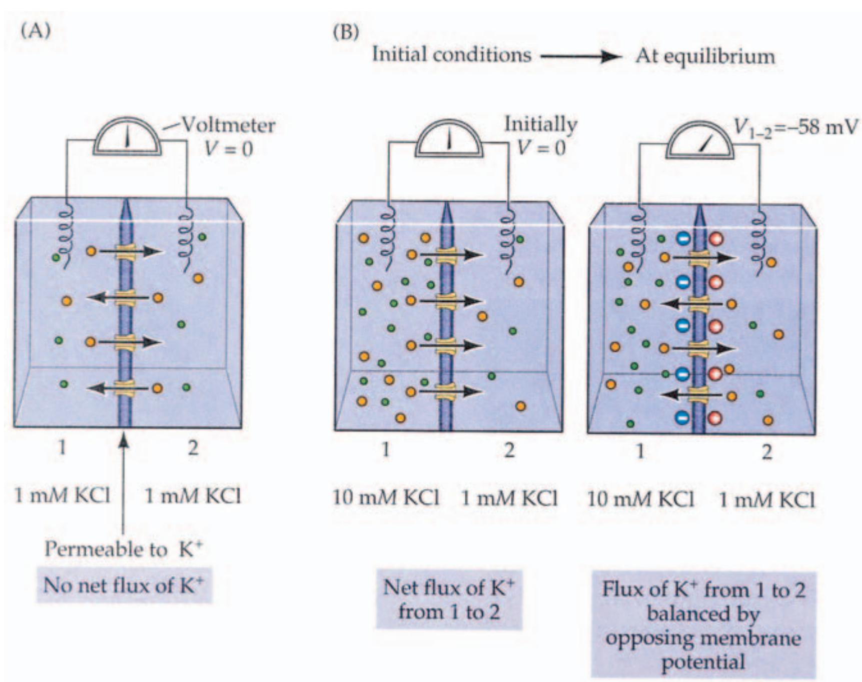


(C)

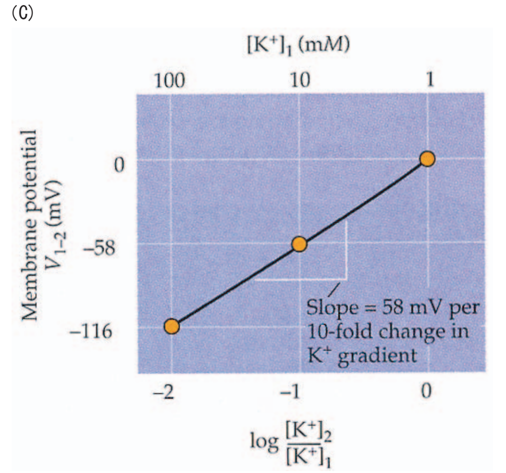


**Figure 2.3 Electrochemical equilibrium**.
(A) A membrane permeable only to $K^+$ separates compartments 1 and 2, which contain the indicated concentrations of KCl. (B) Increasing the KCl concentration in compartment 1 to 10 mM initially causes a small movement of $K^+$ into compartment 2 (initial conditions) until the electromotive force acting on $K^+$ balances the concentration gradient, and the net movement of $K^+$ becomes zero (at equilibrium). (C) The relationship between the transmembrane concentration gradient ( $[K^+]_2 / [K^+]_1$) and the membrane potential. As predicted by the Nernst equation, this relationship is linear when plotted on semilogarithmic coordinates, with a slope of 58 mV per tenfold difference in ʻhe concentration gradient.

④

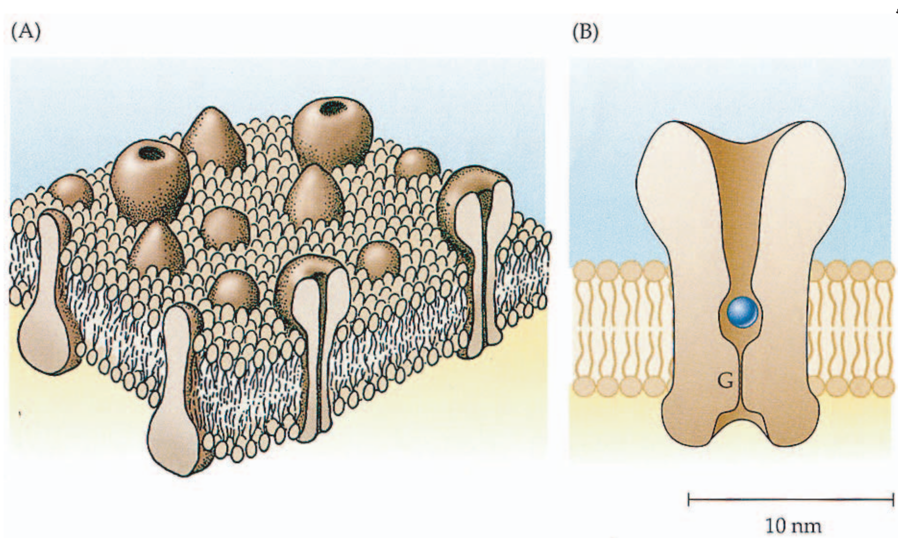


**FIGURE 2.1 Cell Membrane and Ion Channel.**
(A) The cell membrane is composed of a lipid bilayer embedded with proteins. Some of the proteins traverse the lipid layer and some of these membrane-spanning proteins form membrane channels. (B) This schematic representation shows a membrane channel in cross section, with a central water-filled pore and channel "gate" (G). The gate opens and closes irregularly; the probability of opening may be regulated by the membrane potential, by the binding of a ligand to the channel, or by other biophysical or biochemical conditions. A sodium ion, surrounded by a single shell of water molecules, is shown to scale in the pore for size comparison.