Derivation of the Equation for Resting Potential, V_R

Assume $I_{Cl} = 0$

$V_R = E_{Cl}$: $I_{Cl} = g_{Cl} (V_R - E_{Cl})$

Active Currents (carried by the Na^+/K^+ ATPase pump)

3 Na^+ ions exchanged for 2 K^+ ions

Therefore, $(2/3)\ I_{Na}^A = -I_K^A$ eqn. (1)

If there is to be no change in concentration gradients for each ion, then

$I_{Na}^A = -I_{Na}^P$ eqn. (2)

$I_K^A = -I_K^P$ eqn. (3)

The passive currents (through the ion channels) obey Ohm's Law

$I_{Na}^{p} = g_{Na} (V_R - E_{Na})$ eqn. (4)

$I_{K}^{p} = g_{K} (V_R - E_{K})$ eqn. (5)

$$\boxed{\begin{aligned} &(2/3)\ I_{Na}^{A} = -I_{K}^{A} \\ &I_{Na}^{A} = -I_{Na}^{P} \end{aligned}}$$

From eqns. (1) and (2)

$I_{K}^{A} = (2/3)\ I_{Na}^{P}$ eqn. (6)

From eqns. (4) and (6)

$I_{K}^{A} = (2/3)\ g_{Na} (V_R - E_{Na})$ eqn. (7)

From eqns. (3) and (7)

$$-I_K^P = (2/3)\, g_{Na}\, (V_R - E_{Na}) \qquad \text{eqn. (8)}$$

From eqns. (5) and (8)

$$-\, g_K\, (V_R - E_K) = (2/3)\, g_{Na}\, (V_R - E_{Na})$$

Therefore,

$$\boxed{V_R = (g_K\, E_K + (2/3)\, g_{Na}\, E_{Na}) \,/\, (g_K + (2/3)\, g_{Na})}$$

$$I_K^A = -I_K^P$$

$$I_K^p = g_K\, (V_R - E_K)$$

$$I_K^A = (2/3)\, g_{Na}\, (V_R - E_{Na})$$