Basic Electrophysiological Methods
Lecture 5

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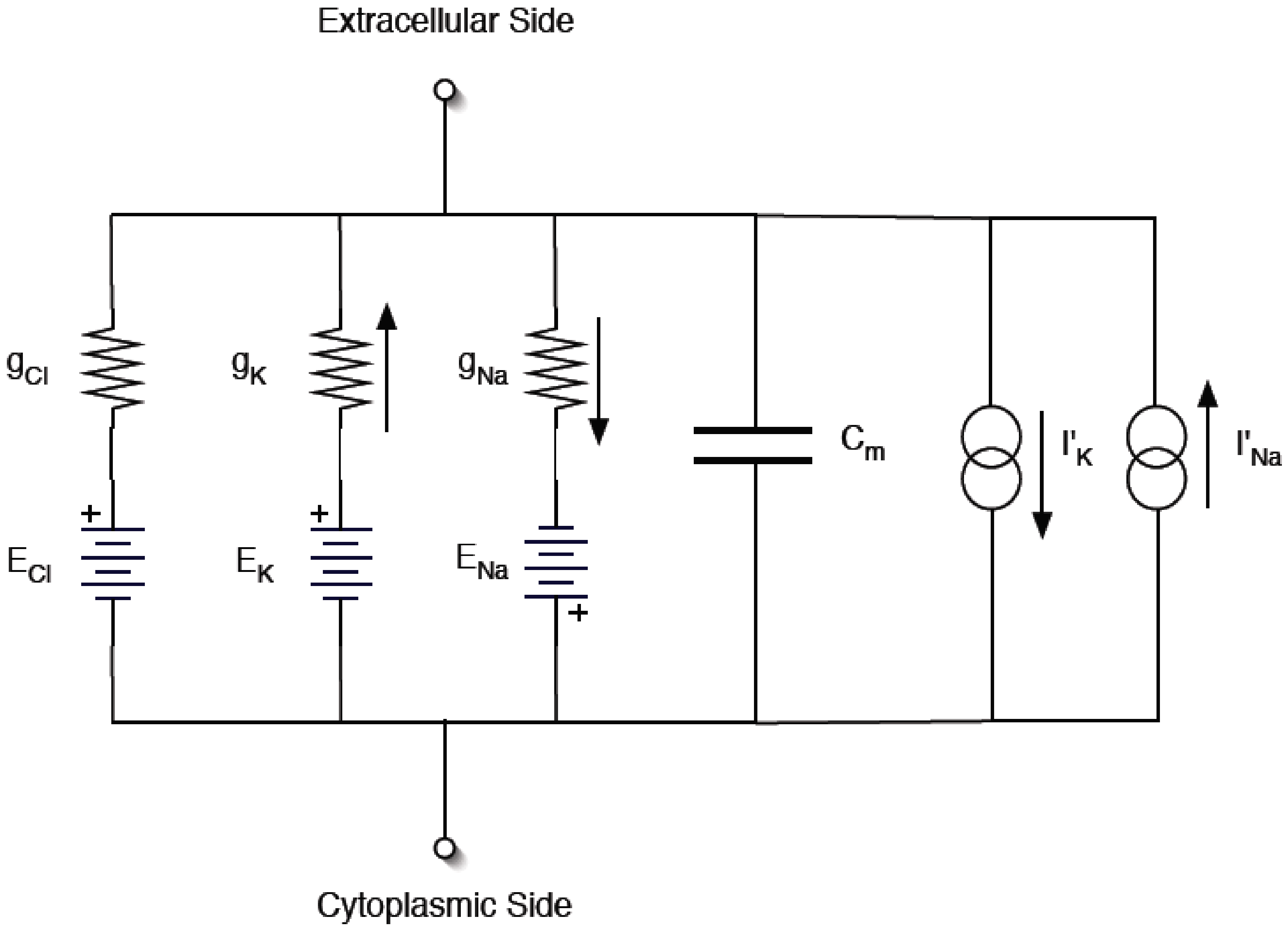
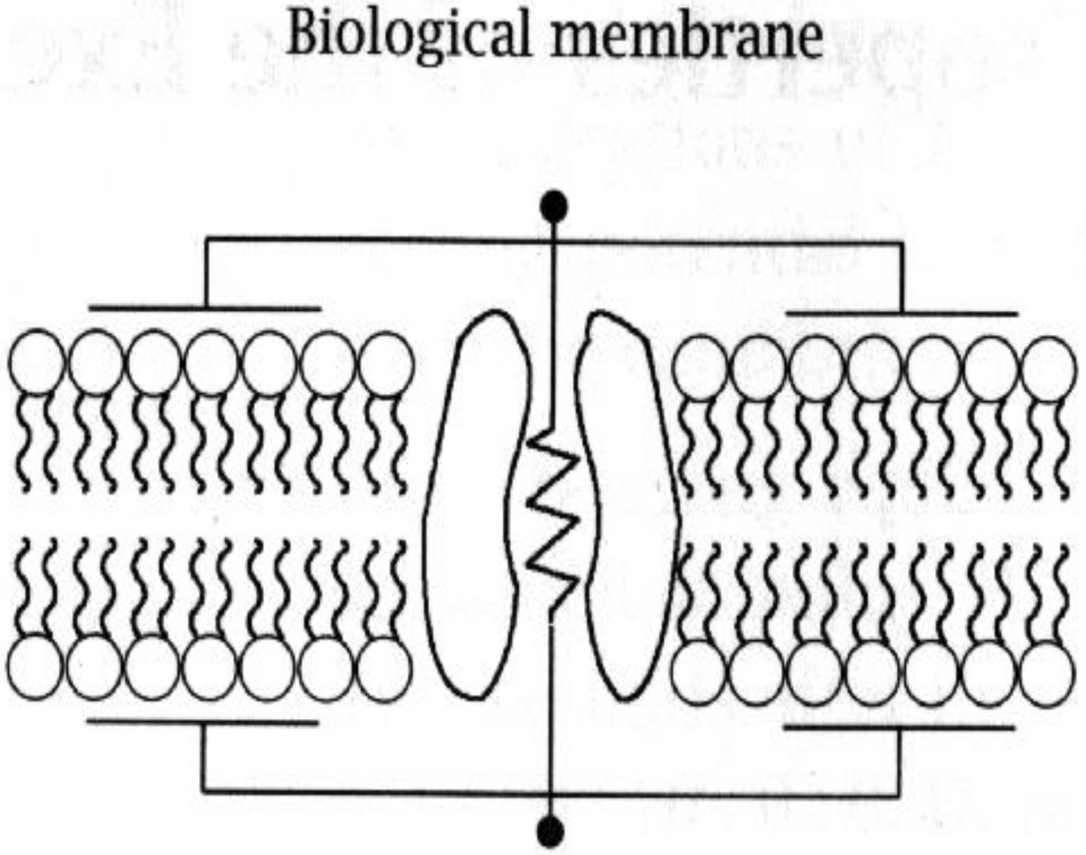
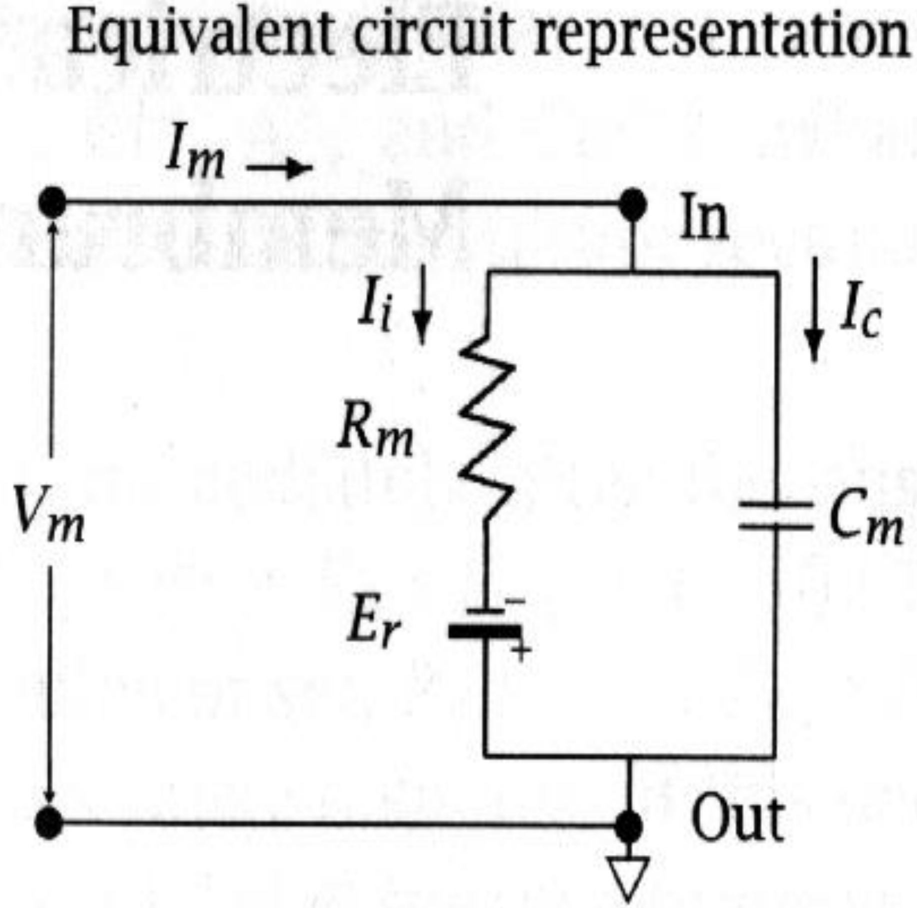
The complete equivalent circuit

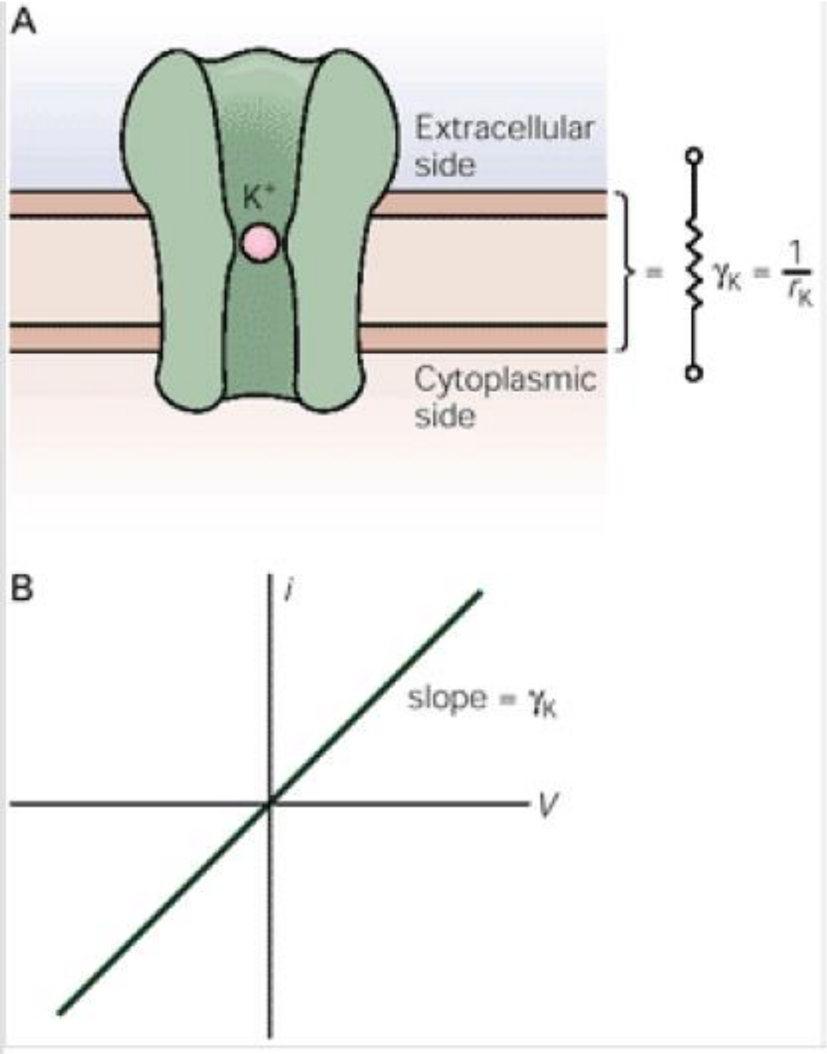


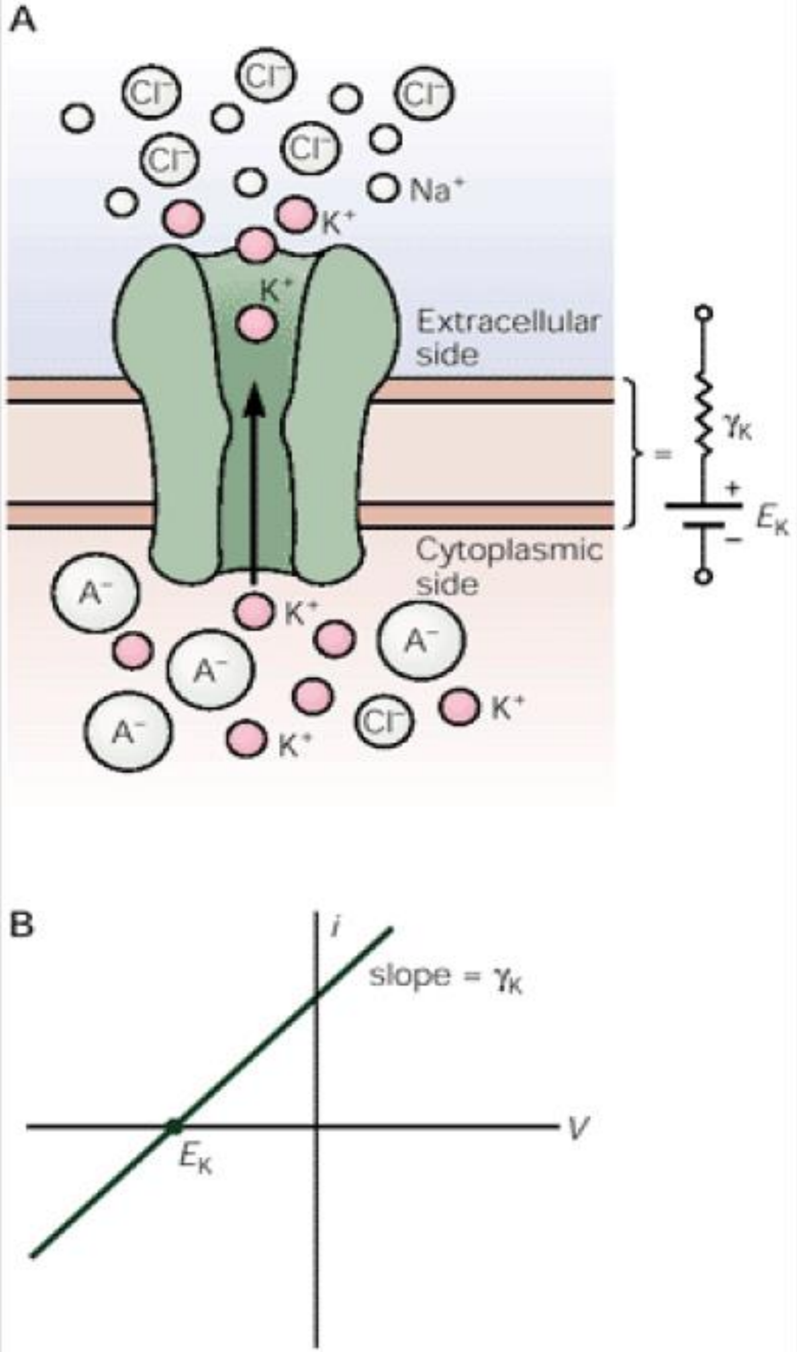
Ohmic model

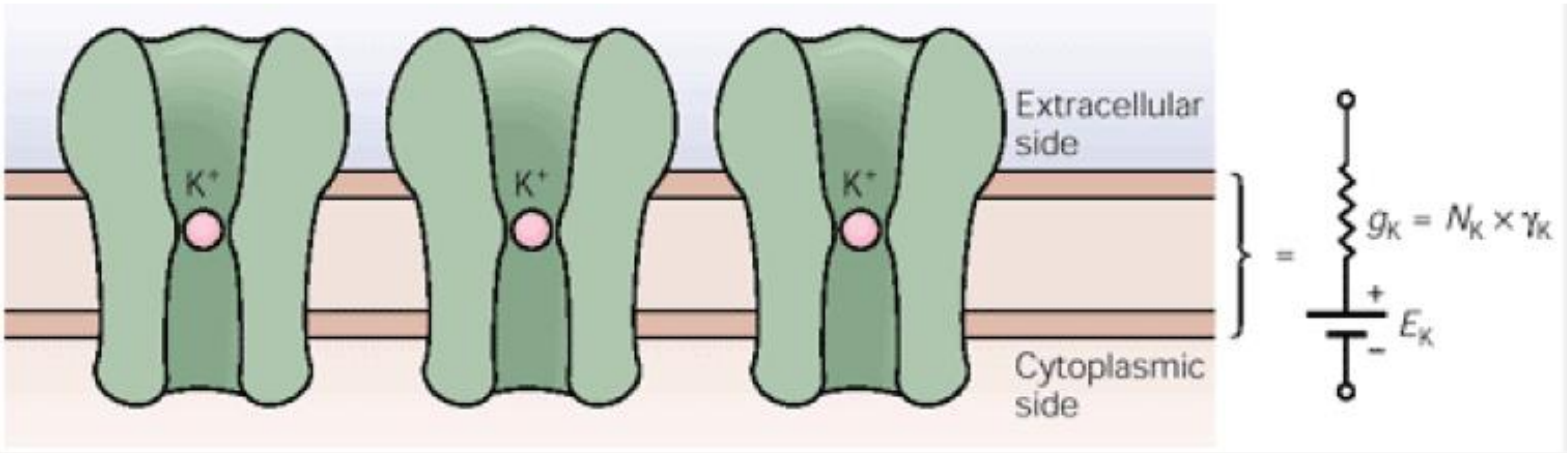

Biological membrane


Equivalent circuit representation
Im
In
Ii
Ic
Rm
Vm
Cm
Er
Out

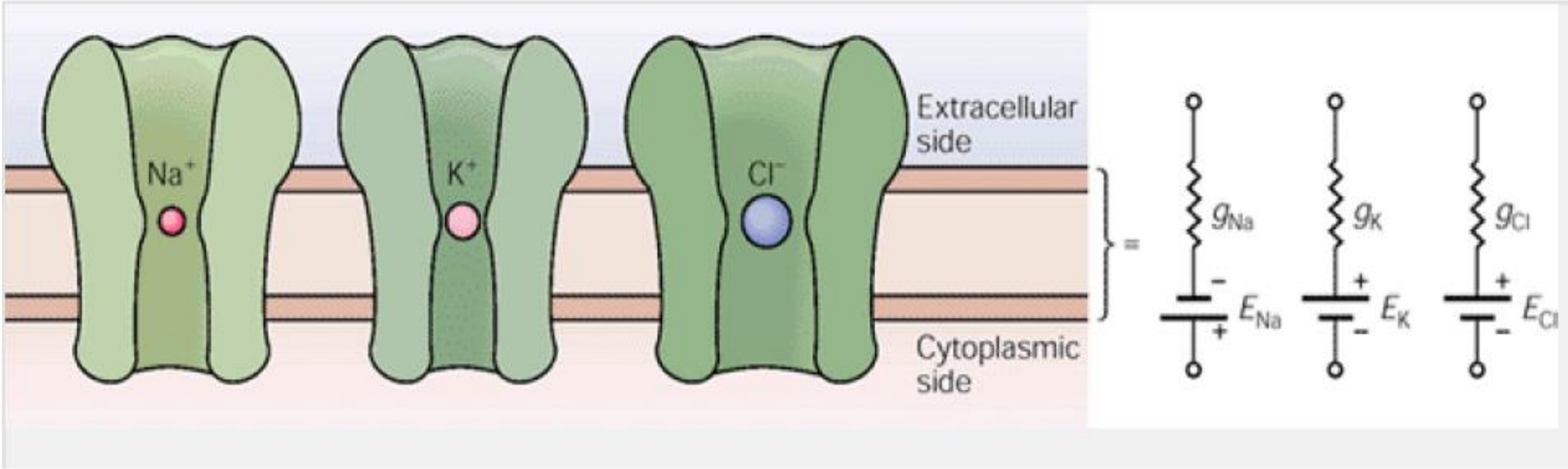
Electrical model of the cell: conductance equation




A
Cl⁻
Na⁺
K⁺
Extracellular side
Cytoplasmic side
A⁻
γK
EK
B
i
slope = γK
V
EK

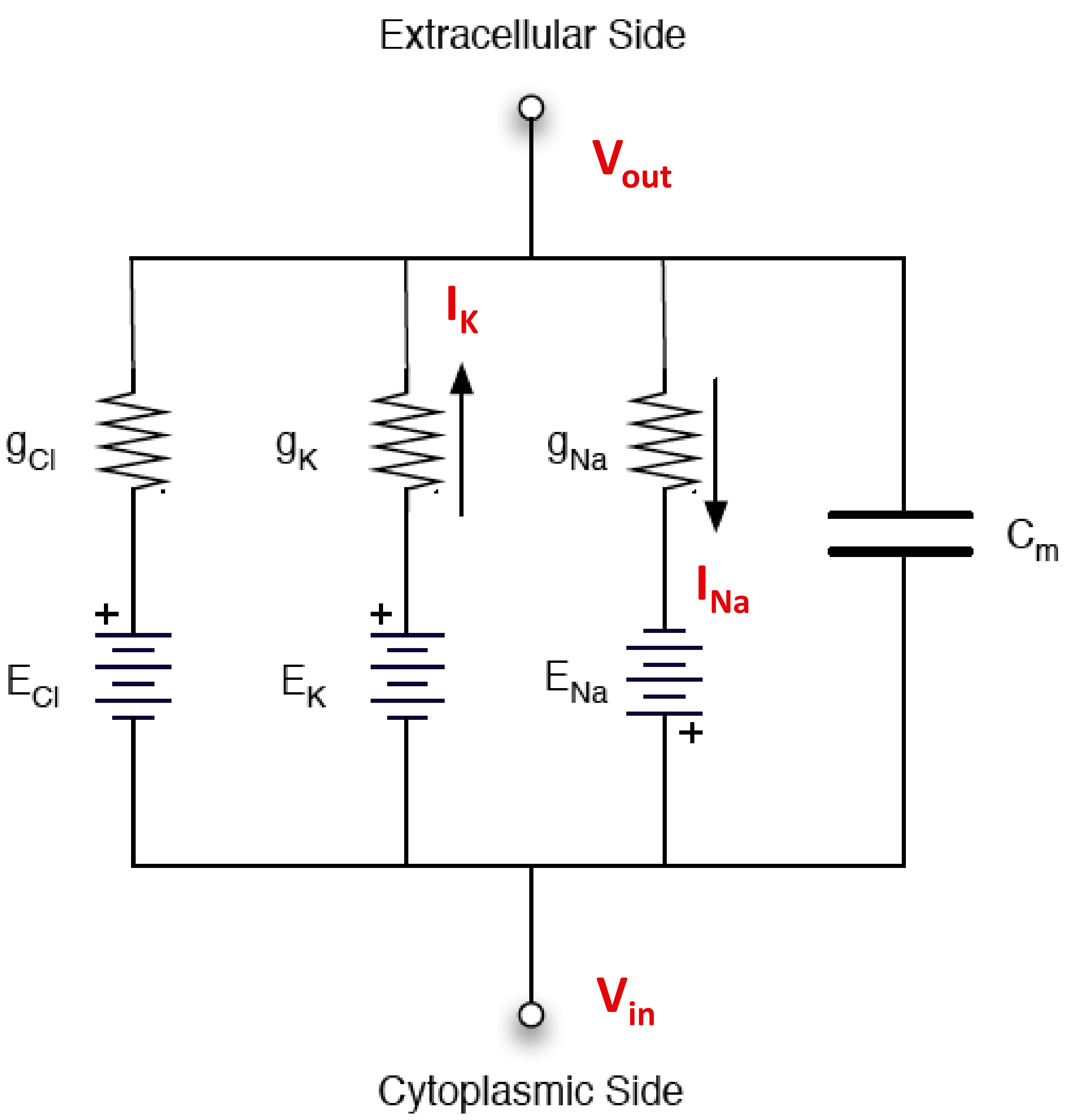


K+
K+
K+
Extracellular
side
Cytoplasmic
side
=
$g_K = N_K \times \gamma_K$
+
E_K
–



Extracellular side
Na+
K+
Cl−
Cytoplasmic side
=
gNa
gK
gCl
ENa
EK
ECl

The passive equivalent circuit



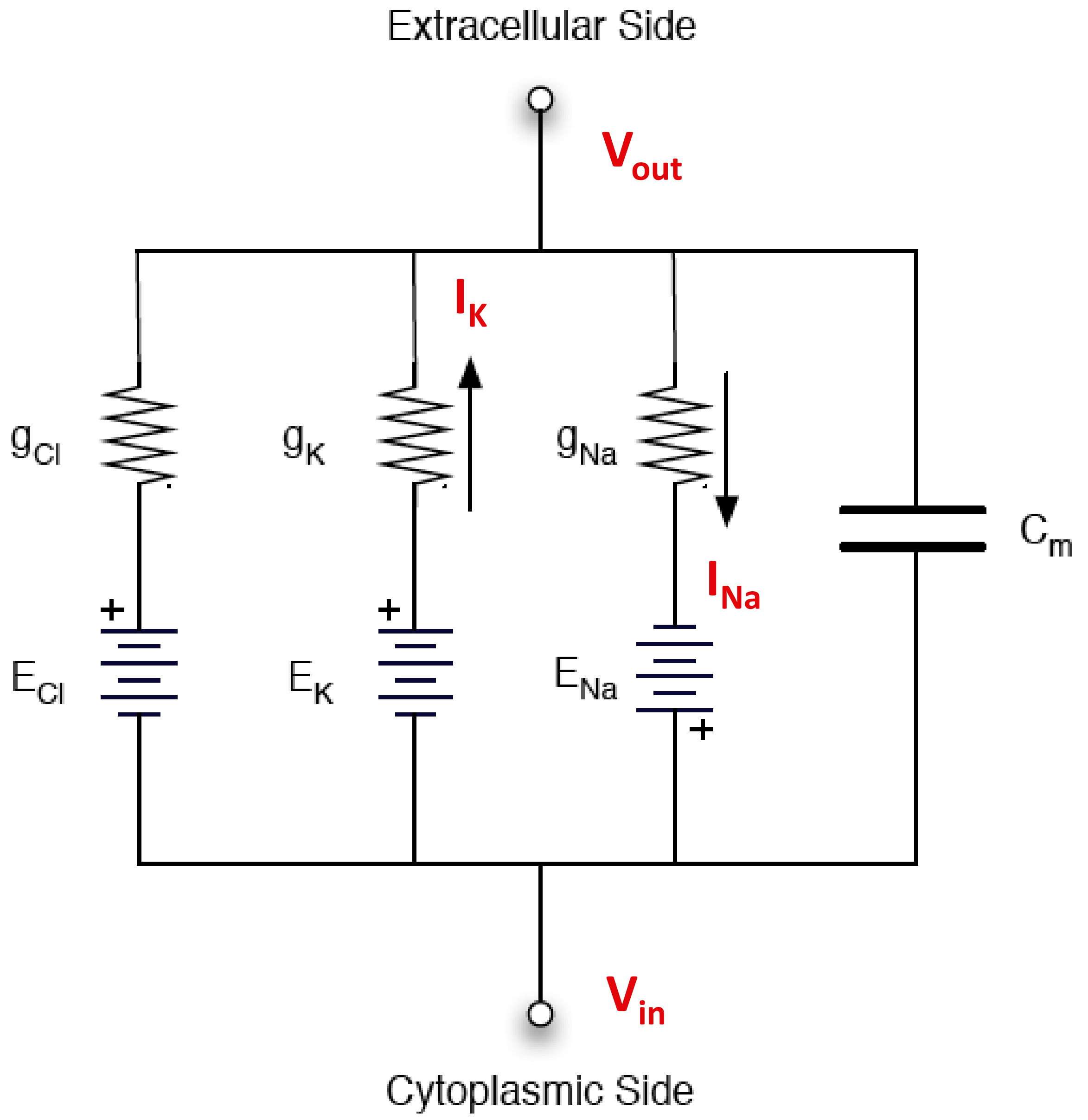
Solving for V_{rest}

1. $I_{Na} + I_K = 0$
2. $V_{in} - V_{out} = E_K + I_K / g_K$
3. $V_{in} - V_{out} = E_{Na} + I_{Na} / g_{Na}$
4. **$I_K = g_K(V_m - E_K)$**
5. **$I_{Na} = g_{Na}(V_m - E_{Na})$**

Finally,

$$V_m = \frac{(E_{Na}g_{Na} + E_K g_K)}{g_{Na} + g_K}$$

The passive equivalent circuit

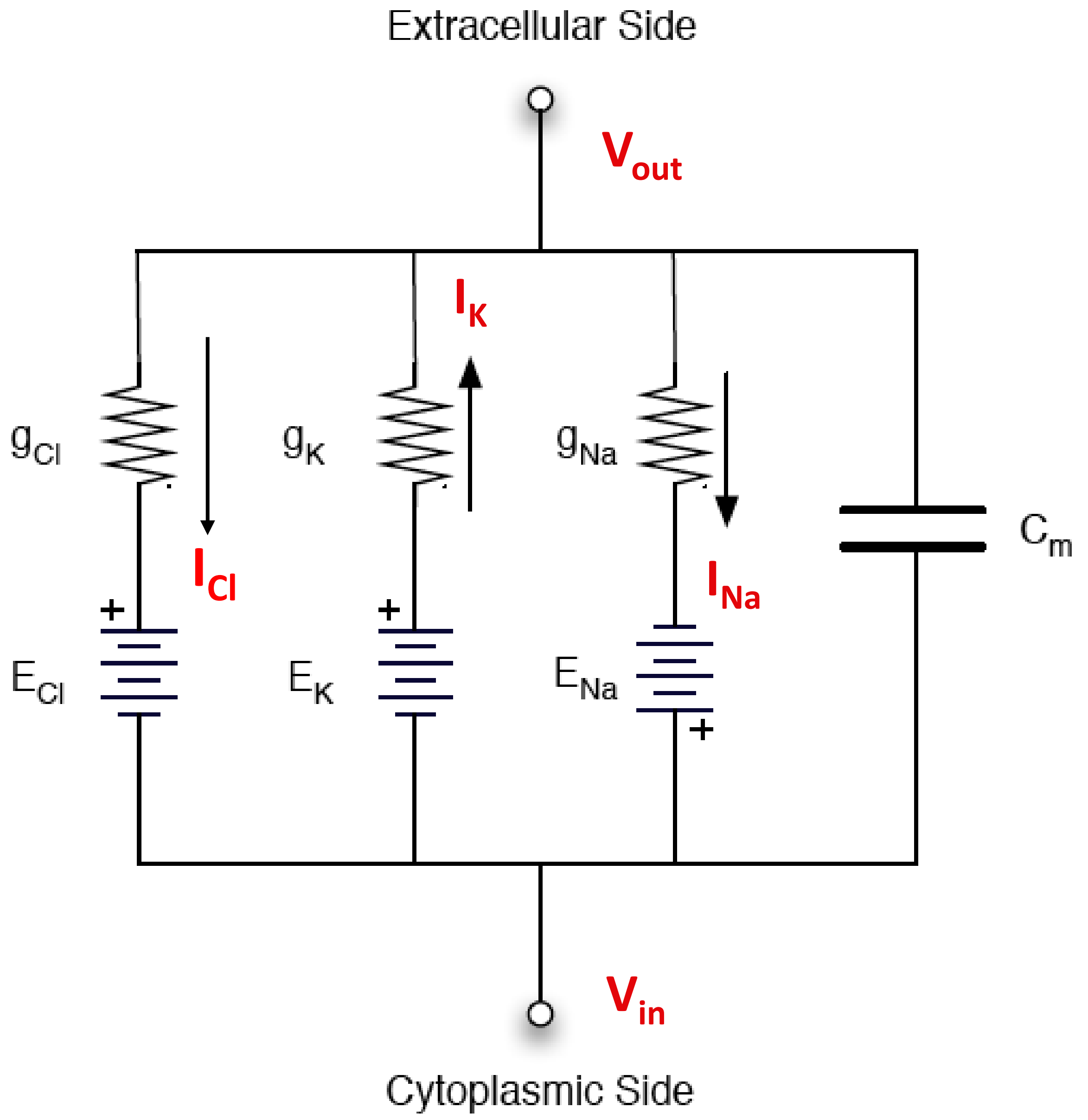


Solving for V_{rest}

1. $R_{Na} = 5.10^6 \Omega$
2. $R_K = 0.2.10^6 \Omega$
3. $R_{Cl} = 0.5.10^6 \Omega$
4. $E_{Na} = 55mV$
5. $E_K = -75mV$
6. $E_{Cl} = -70mV$

$V_m = ?$

The passive equivalent circuit



Solving for V_{rest}

1. $R_{Na} = 5.10^6 \Omega$
2. $R_K = 0.2.10^6 \Omega$
3. $R_{Cl} = 0.5.10^6 \Omega$
4. $E_{Na} = 55mV$
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6. $E_{Cl} = -70mV$

$V_m = ?$