Gibbs Free Energy

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Gibbs Free Energy

- If we combaine the two thermodynamics law;

$$\delta Q = dU + \delta W \qquad \delta Q = TdS$$

$$TdS \geq \delta Q = dU + \delta W$$

Work done by the system; $\delta W = PdV + dW^*$

dW^* other parameteres rather than PdV

dW^*

$$\delta W = PdV + Fdx + \Phi dq + ...$$

$\delta W^* \leq -(dU + PdV - TdS)$

Gibbs free energy;

$$G = U + PV - TS$$

Gibbs Free Energy

$G=U+PV-TS$

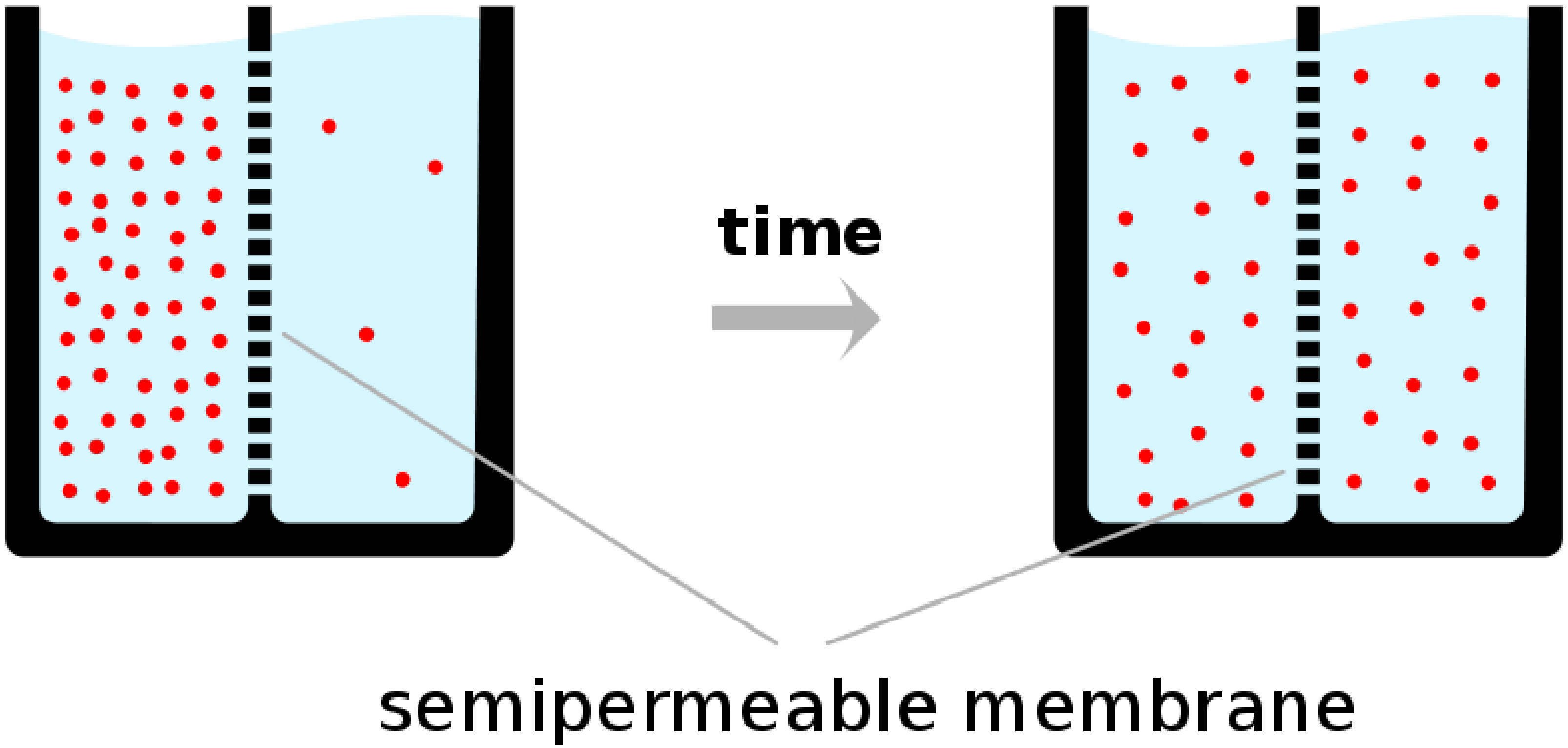
- $G_i=G_i^0+RT\ln c_i+z_iFV+Pv_i$……

G_i^0 initial free energy

- **If the gibbs free energy is decreasing means that entropy is increasing**

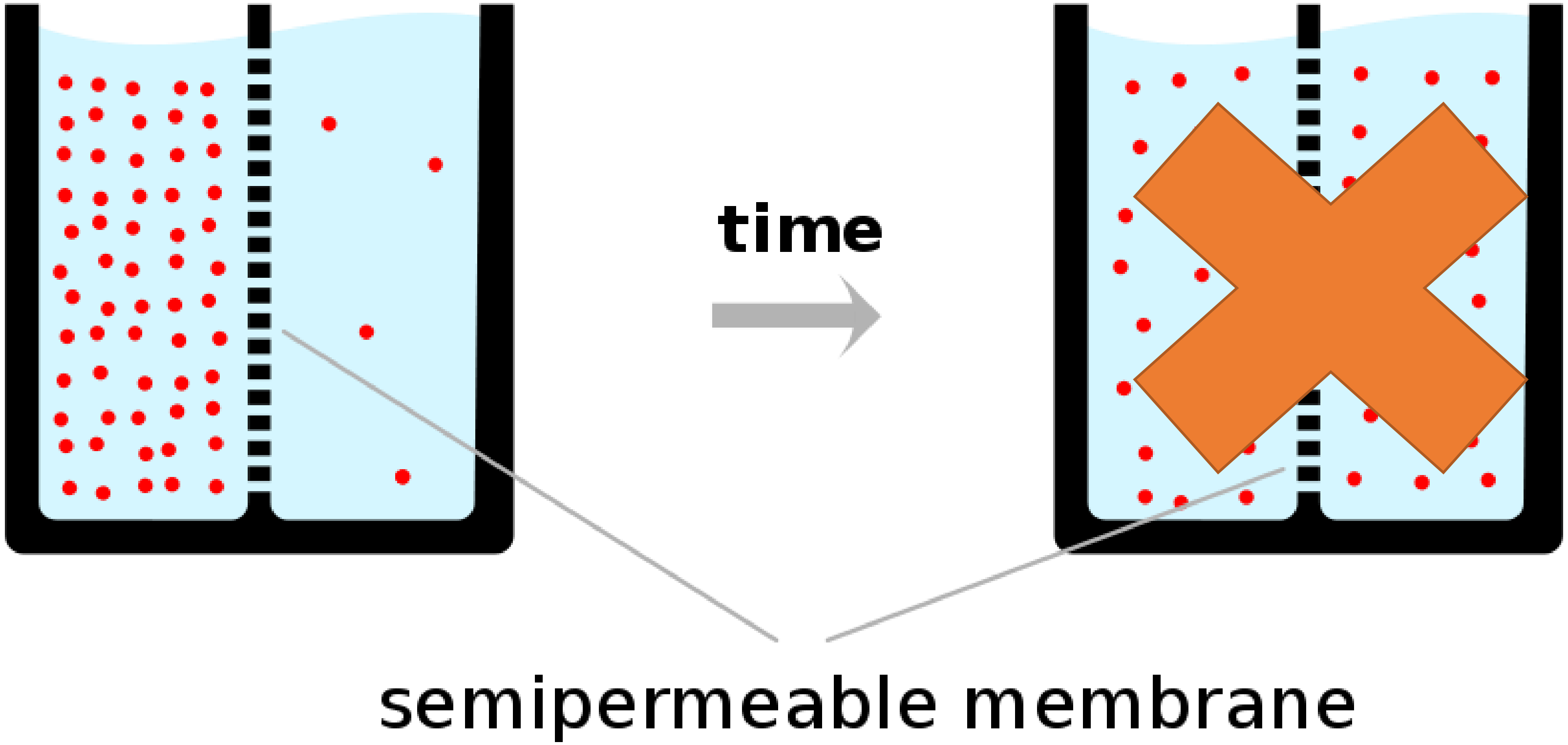
Nernst Equation:

$$Gi = Gi^0 + RT\ln ci$$



Nernst Equation:

$$G_i = G_i^0 + RT \ln c_i$$



Nernst Equation:

$$Gi=Gi^0+RTlnci$$

$$G_i = G°_i + RT \ln c_i + z_i F V + P v_i + \ldots \quad [J/mol]$$

$$G_i^{iç} = G_i^{dış}$$

$$RT \ln c_i^{iç} + z_i FV^{iç} + \ldots = RT \ln c_i^{dış} + z_i FV^{dış} + \ldots$$

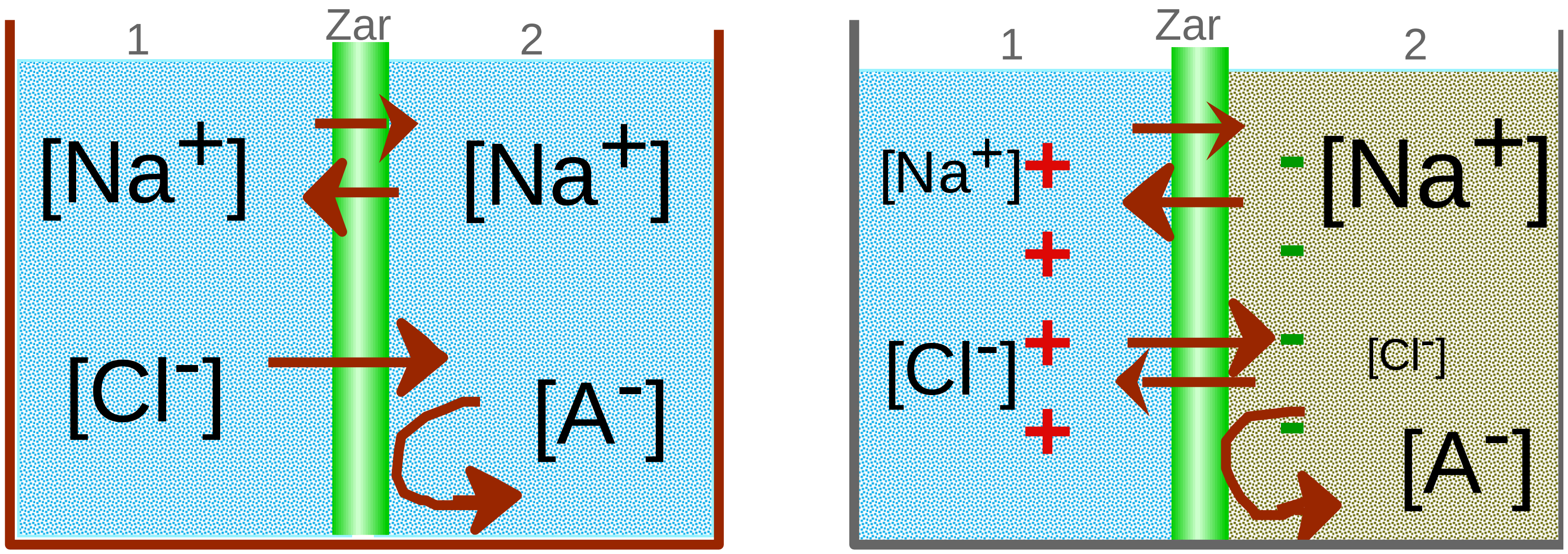
Nernst Equation:

$$E_i = V^i - V^o = \frac{RT}{z_i F} \ln \frac{c_i^{\ o}}{c_i^{\ i}}$$

RT/F=25.67mV

Z=Valence of the electron
E= Electrical potential
Ci=intracellular concentration of an ion
C^0 =extraracellular concentration of an ion

Gibbs-Donnan Equilibrium

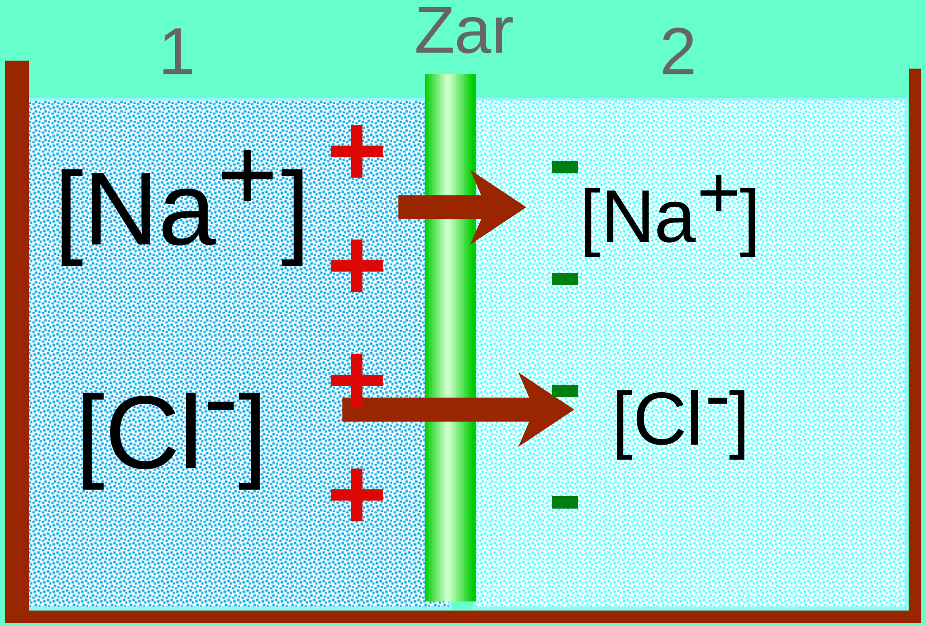


$$G°_{Na+} + RT \ln [Na^+]_1 + FV_1 = G°_{Na+} + RT \ln [Na^+]_2 + FV_2$$

$$G°_{Cl-} + RT \ln [Cl^-]_1 - FV_1 = G°_{Cl-} + RT \ln [Cl^-]_2 - FV_2$$

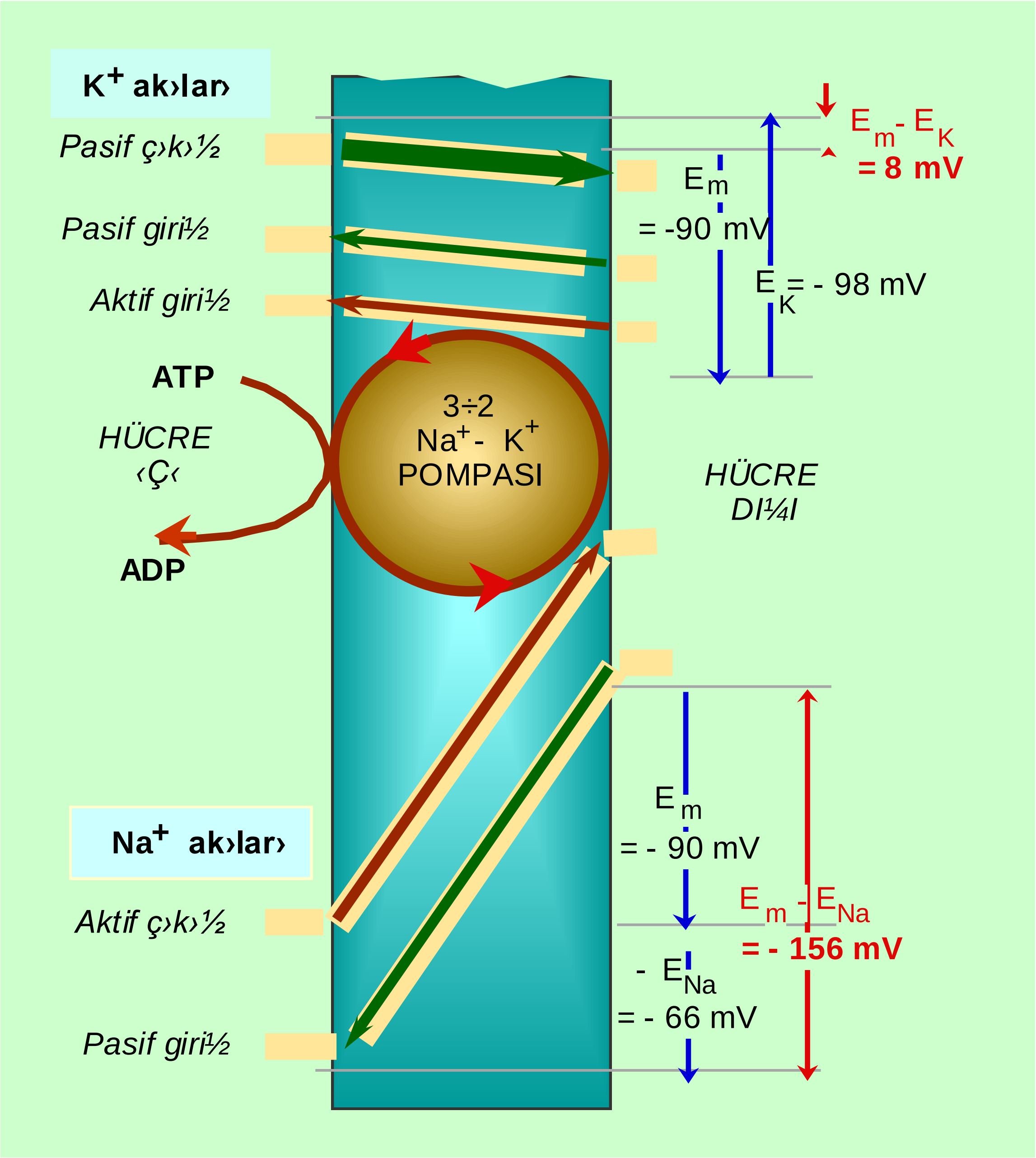
$$[Na^+]_1 = [Cl^-]_1 = c_1 \text{ ve } [Na^+]_2 = [Cl^-]_2 + [A^-]$$

Diffusion Potential



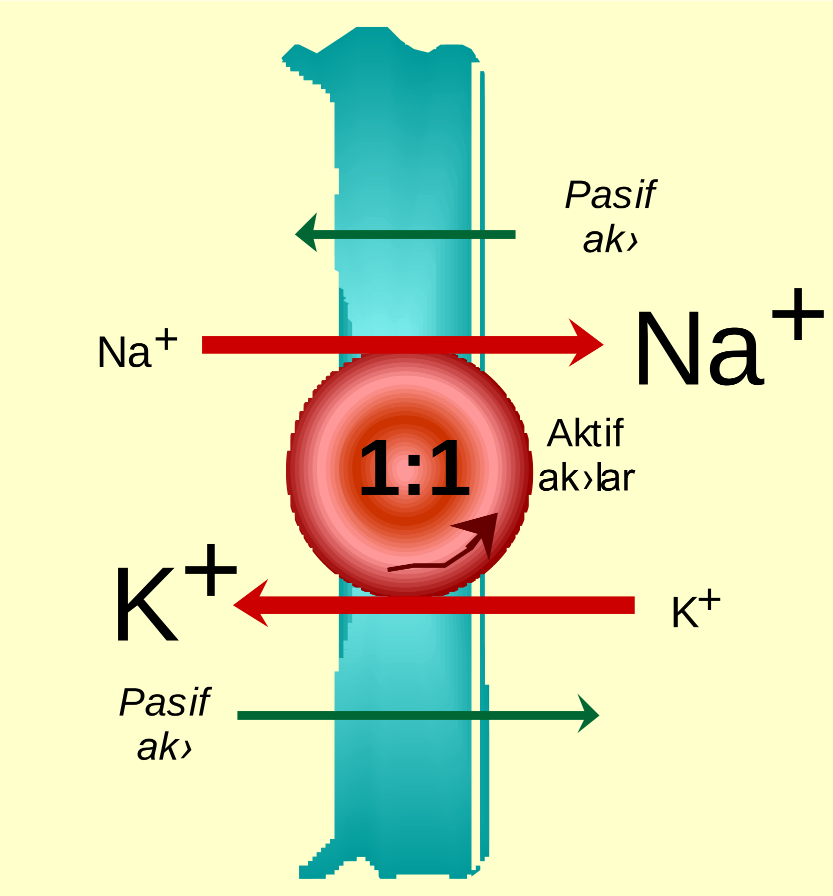
$$V = \frac{RT}{F}\frac{\mu_{Na} - \mu_{Cl}}{\mu_{Na} + \mu_{Cl}} \ln\frac{[c]_1}{[c]_2}$$

$P_i = D_i / \delta = \mu_i RT / (z_i F \delta)$ [m/s]



K+ ak›lar›
Pasif ç›k›½
Pasif giri½
Aktif giri½
ATP
HÜCRE
‹Ç‹
ADP
3÷2
Na+- K+
POMPASI
Em
= -90 mV
EK = - 98 mV
Em - EK
= 8 mV
HÜCRE
DI¼I
Na+ ak›lar›
Aktif ç›k›½
Pasif giri½
Em
= - 90 mV
- ENa
= - 66 mV
Em - ENa
= - 156 mV

Gradient in cell membrane produced by pumps



Even if pump work as 1:1 ratio, it may still produce gradient

Goldman-Hodgkin-Katz Equation

The **Nernst equation** calculates the **equilibrium potential** (also referred to as the **Nernst potential**) for an ion based on the charge on the ion (i.e., its valence) and its concentration gradient across the membrane.

$$J = J_{Na} + J_K + J_{Cl}$$

$$E_m = \frac{RT}{F} \ln \frac{P_K[K^+]^{d›½} + P_{Na}[Na^+]^{d›½} + P_{Cl}[Cl^-]^{iç}}{P_K[K^+]^{iç} + P_{Na}[Na^+]^{iç} + P_{Cl}[Cl^-]^{d›½}}$$

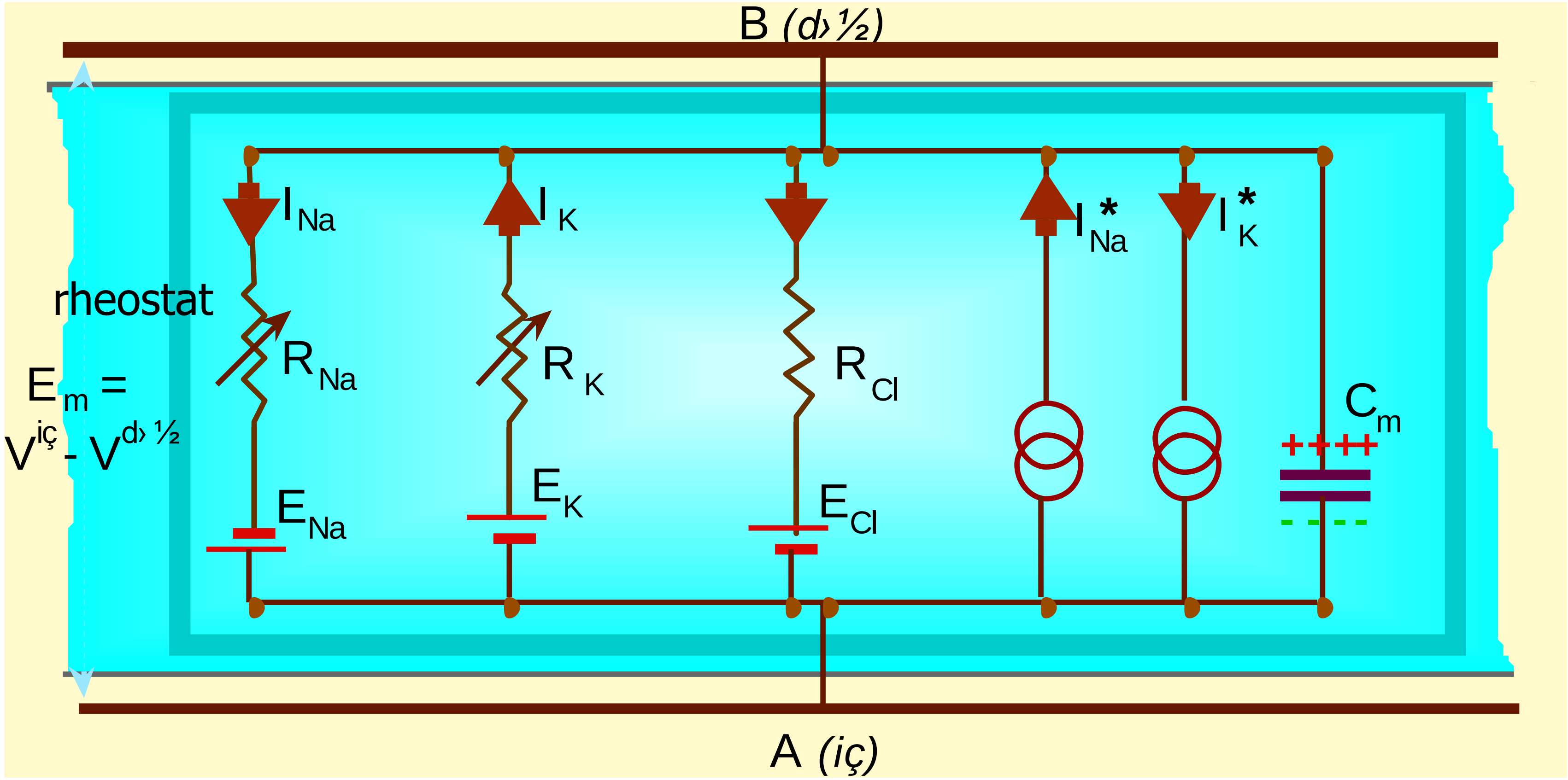
$$P_K \div P_{Na} \div P_{Cl} \approx 1 \div 0{,}04 \div 0{,}45$$

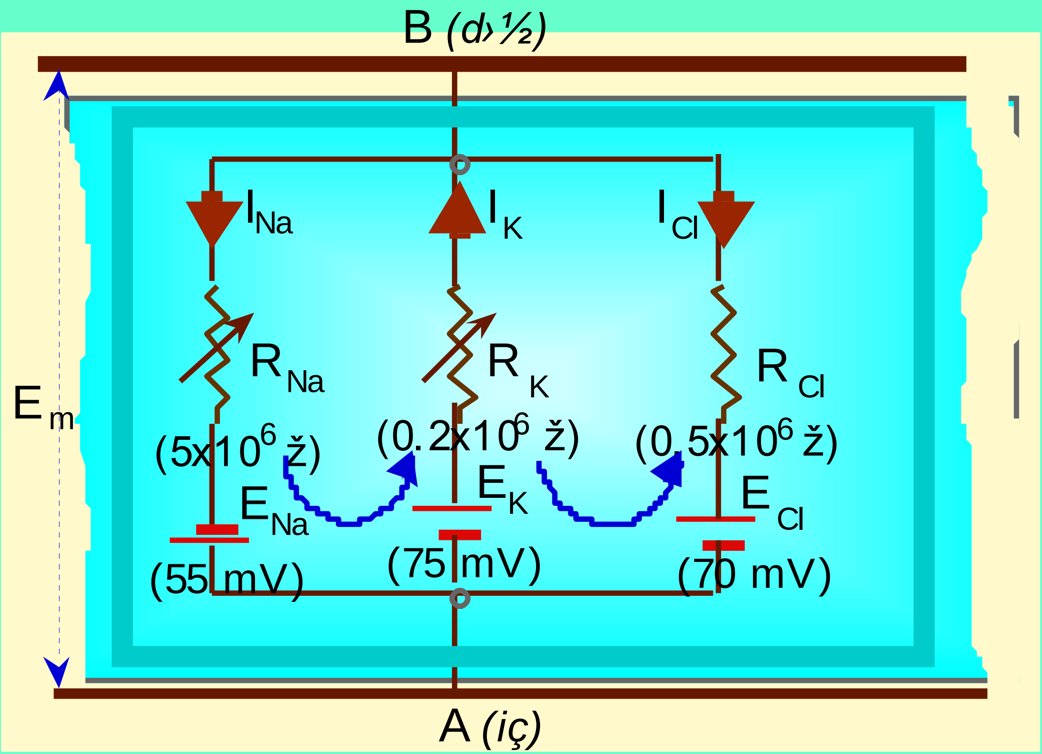
Resting membrane potential

For, P_K>> P_{Na}, P_{Cl}

$$E_m \approx \frac{RT}{F} \ln \frac{[K^+]^{d›½}}{[K^+]^{iç}} \rightarrow E_K$$

Equivalent electric circuit for the ion-selective membrane




B (dış)
I Na
I K
I Cl
R Na
R K
R Cl
E m
(5x10⁶ ž)
(0.2x10⁶ ž)
(0.5x10⁶ ž)
E Na
E K
E Cl
(55 mV)
(75 mV)
(70 mV)
A (iç)