Na-K-CL: Mathematical model of Na-K-Cl homeostasis

Anton Chizhov

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The dynamics , and is governed by the state variables of the excitatory population, which are the mean voltage , the mean total potassium current , the total GABAergic current and the firing rate . The main equations are as follows:

$$\begin{aligned}
I\_{K-pump}&=&\frac{-2 I\_{Na-K-pump}^{max}}{(1+[K]\_{o}^\alpha/[K]\_{o})^2 ~(1+[Na]\_{in}^\alpha/[Na]\_{in})^3}; \\
I\_{K} &=& I\_{K, leak} + I^E\_{K-tot} \\ I\_{Cl}}&=&I\_{Cl, leak} - I^E\_{GABA-tot}; \end{aligned}$$

$$\begin{aligned}
k\_2&=&{k\_1}/{(1+\exp(-(K-15\hbox{mM})/1.15\hbox{mM})};\\
\frac{dB}{dt}&=&k\_1 (B\_{max}-B) - k\_2 B; \\
G &=& k\_1 (B\_{max}-B)/k\_{1N} - k\_2 B; \end{aligned}$$

$$\begin{aligned}
V\_{Cl} &=&0.0266 ~\ln(([Cl]\_{in}-[Cl]\_{shift}) /[Cl]\_o); \\
V\_{K} &=&0.0266 ~\ln([K]\_{o} /[K]\_i); \\
V\_{Na} &=&0.0266 ~\ln([Na]\_o/[Na]\_{in}); \\
V\_{GABA}&=&0.0266 ~\ln((4[Cl]\_{in}+[HCO\_3]\_{in})/(4 [Cl]\_o+[HCO\_3]\_{out})) $$

$$\begin{aligned}
I\_{K, leak}&=&g\_{L,K}(\overline{U^{\E}}-V\_K}), \\
I\_{Cl, leak}&=&g\_{L,Cl}(\overline{U^{\E}}-V\_{Cl}}), \\
I\_{Na, leak}&=&g\_{L,Na}(\overline{U^{\E}}-V\_{Na}}), \end{aligned}$$

$$\begin{aligned}
\overline{U^{\E}}=\int\_0^{\infty} U(t,\ts) ~\rho(t,\ts) ~d\ts\end{aligned}$$

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