Quiz 2.3: Model of an ion channel

Biological interpretation of parameters

0 points possible (ungraded)

Consider the following model for an ion channel which is going to be opened by depolarization: the electrical current I_{ion} through the channel is given by

$$I_{ion} = g_{ion} r^{n_1} s^{n_2} (u - u_{ion})$$

where u is the membrane potential of the neuron, g_{ion} and u_{ion} are two constants, and $n_1 = 2, n_2 = 1$. The quantities r and s obey the equations

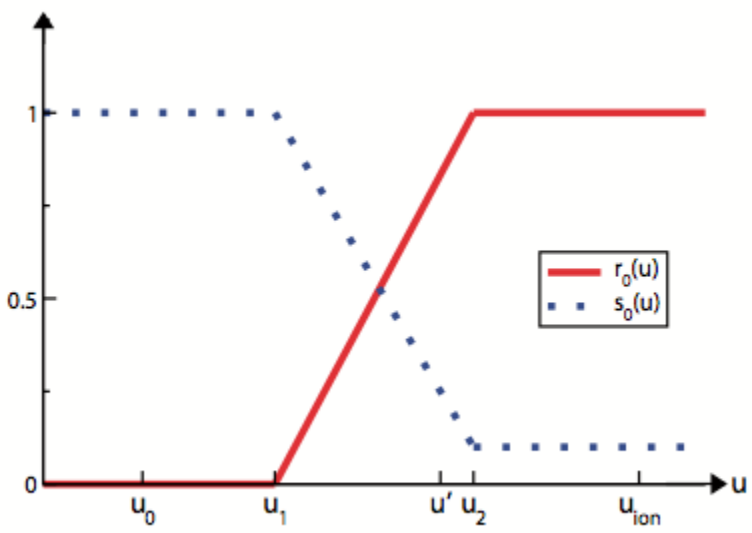
$$\frac{dr}{dt} = -\frac{r - r_0(u)}{\tau_r(u)}$$

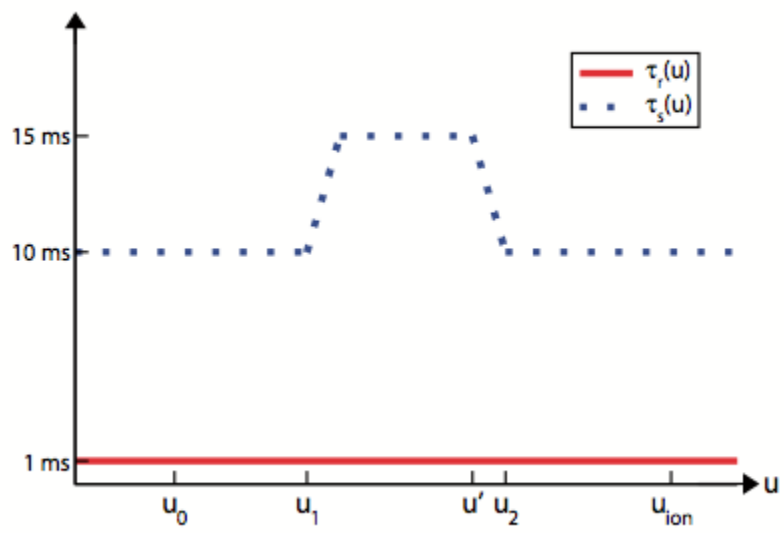
$$\frac{ds}{dt} = -\frac{s - s_0(u)}{\tau_s(u)}$$

Fix n，电压变大，因为tau_r较小，所以r_0迅速到峰值1。r迅速增加，导电性增加，电流增加。
随后，s开始变成0，s_0变成0，导电性减少，电流减少。

Fix s,t，n越大，开的channel越多，导电性也越大。

with r_0, s_0, τ_r, and τ_s as shown in the following figure.





1. Which of the followings are correct in terms of *biological* interpretation of the parameters introduces above?

- [ ] r^{n1} is the fraction of open channels. ✔

我觉得是n1

- [ ] $1 - r^{n1}$ is the probability that a single channel is open.

我觉得是r，因为n1 = 1了啊

- [x] $1 - s$ is the fraction of inactivated channels. ✔
- [x] The channel is activated before it is inactivated due to the fact that $\tau_r < \tau_s$. ✔

tau越小越快到达峰值，存在一个速度差。

- [x] g_{ion} is the maximal conductance for the ion under consideration. ✔
- [ ] g_{ion} might be considered as conductance of a single channel times total number of channels. ✔
- [x] u_{ion} is the reversal potential. ✔

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You have used 1 of 1 attempt

Answers are displayed within the problem

Evolution of membrane potential

0 points possible (ungraded)

2. How does the channel react (in terms of partial or full opening/closing) to a step change in membrane potential? Suppose that for $t < 0$, the membrane potential is clamped at a value u_0, and that at $t = 0$ it instantaneously jumps to a value $u' = u_2\ (1 - \delta)$ with $\delta \ll 1$. See the figure above for the values of $u_0, u', u_2,$ and u_{ion} where it is maintained for all $t \geq 0$.

- [x] For $t < 0\ ms$ the channel is closed because $r = 0$.
- [x] At $t = 1\ ms$, the channel is partially open because $r_0 \simeq 1\ and\ \tau_r \simeq 1ms$ and so $r \simeq 1 - e^{-1} \simeq 0.6$.
- [ ] At $t = 3\ ms$ the channel is closed because $s \simeq 0$
- [x] At $t = 3\ ms$ the channel is almost completely open because $r \simeq 1$ but $s \simeq 1$ due to its long time constant ($15\ ms$).
- [x] At $t = 20\ ms$ the channel is partially closed because $20\ ms > tau_s$ and $s_0 \simeq 0.2$.
- [ ] At $t = 20\ ms$ the channel is opened because $s \simeq 1$.
- [x] At $t = 100\ ms$ the channel is almost completely closed because $s \simeq 0.2$.

✔

Submit You have used 1 of 1 attempt

Answers are displayed within the problem

Discussion

Topic: Week 2 / Quiz 2.3: Model of an ion channel

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