BMC Neuroscience

POSTER PRESENTATION | Open Access

The intrinsic and synaptic responsiveness of a new realistic Purkinje cell model

Stefano Masoli[1*], Sergio Solinas[2], Egidio D'Angelo[1,2]

From Twenty Second Annual Computational Neuroscience Meeting: CNS*2013
Paris, France. 13-18 July 2013

The latest discoveries on Purkinje cell (PC) physiology suggest that the mechanisms of PCs intrinsic excitability have to be revisited. Starting from available models [1], we have constructed a new PC model in Python-NEURON, which explicitly accounts for the Axon Initial Segment (AIS) [2-4] and a part of the axon including the first node of Ranvier (RVN). The fast Na+ channels are located in AIS, soma with initial dendrite and RVN [4]. The K+ delayed rectifier channels are located only in the soma. The Ca2+ and Ca2+-dependent K+ channels, including SK2, as well as intracellular Ca2+ dynamics have been updated [5]. The new model configuration now generates simple spike (SS) firing reproducing the experimental input-output curve[6]. SSs initiate in AIS and then back-propagate into the soma decaying sharply inside the dendritic tree. Activation of parallel fiber (pf) generates a short burst followed by a pause caused by Stellate cells. Following a complex spike (CS), SS activity is interrupted independently of the inhibitory synaptic input. Interestingly, the model can shift its state from silent to autorhythmic (configuring a bistable behavior) upon transient current injection or activation of CFs. The pf and granule cell ascending axon (aa) synapses have been modeled using a stochastic release mechanism activating AMPA synaptic receptors. The facilitation and depression profiles of pf and aa synapses faithfully reproduce the experimental data. This model provides a valuable tool to further investigate the Purkinje cell function in cerebellar network models.

* Correspondence: stefano.masoli01@universitadipavia.it
[1]Department of Brain and Behavioural Science, Neurophysiology and Neurocomputation Unit, University of Pavia, Via Forlanini 6, I-27100, Pavia, Italy
Full list of author information is available at the end of the article

Author details
[1]Department of Brain and Behavioural Science, Neurophysiology and Neurocomputation Unit, University of Pavia, Via Forlanini 6, I-27100, Pavia, Italy. [2]Brain Connectivity Center, Istituto Neurologico IRCCS C. Mondino, Pavia, I-27100, Italy.

Published: 8 July 2013

References

1. De Schutter E, Bower JM: **An active membrane model of the cerebellar Purkinje cell. I. Simulation of current clamps in slice.** *Journal of neurophysiology* 1994, **71**:375-400.
2. Palmer LM, Clark BA, Gr J, Roth A, Stuart GJ, Michael H: **Initiation of simple and complex spikes in cerebellar Purkinje cells.** *Society* 2010, **10**:1709-1717.
3. Foust A, Popovic M, Zecevic D, Mccormick DA: **Action Potentials Initiate in the Axon Initial Segment and Propagate through Axon Collaterals Reliably in Cerebellar Purkinje Neurons.** *Methods* 2010, **30**:6891-6902.
4. Zonta B, Desmazieres A, Rinaldi A, Tait S, Sherman DL, Nolan MF, Brophy PJ: **A critical role for Neurofascin in regulating action potential initiation through maintenance of the axon initial segment.** *Neuron* 2011, **69**:945-56.
5. Lorincz A, Nusser Z: **Cell-type-dependent molecular composition of the axon initial segment.** *The Journal of neuroscience : the official journal of the Society for Neuroscience* 2008, **28**:14329-40.
6. Anwar H, Hong S, De Schutter E: **Controlling Ca2+-Activated K+ Channels with Models of Ca2+ Buffering in Purkinje Cells.** *The Cerebellum* 2010, 1-13.
7. Khaliq ZM, Gouwens NW, Raman IM: **The contribution of resurgent sodium current to high-frequency firing in Purkinje neurons: an experimental and modeling study.** *Journal of Neuroscience* 2003, **23**:4899-4912.

doi:10.1186/1471-2202-14-S1-P80
Cite this article as: Masoli *et al.*: The intrinsic and synaptic responsiveness of a new realistic Purkinje cell model. *BMC Neuroscience* 2013 **14**(Suppl 1):P80.