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# Modeling UBC intrinsic excitability

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Unipolar brush cells (UBCs) are excitatory glutamatergic interneurons of the cerebellar granular layer receiving both primary and secondary vestibular inputs through mossy fibers (excitatory input) and Golgi axon (inhibitory input). The brush like structure of the dendrite allows to form a giant synapses in the glomerulus and to produce an all or none post synaptic response with short delay and protracted kinetics. The excitable response of UBCs can be either a tonic discharge or a high-frequency burst of action potentials. When injected with progressively increasing depolarizing currents from a negative membrane potential, the UBC generates a burst sustained by a calcium spike (Figure 1, +20pA) and then a protracted discharge with shorter latency and spike frequency adaption (Figure 1, +25pA). The intrinsic excitability of UBCs is determined by an H current and by Low Voltage activated and High Voltage activated calcium currents [2,3]. Fast inactivating T-type Calcium channels generate low-threshold spikes and L-type Calcium channel sustain tonic firing. The H current (activated between -60mV and -80mV) produces a slow hyperpolarization characterized by a "sag" in response to a hyperpolarizing step (Figure 1, -16pA) and an afterhyperpolarization at the end of a depolarizing step.

## Conclusions

Here we present a biologically realistic multi-compartmental mathematical model of the UBC realized with the NEURON simulator. According to literature [1-4], ionic channels are distributed among compartments (soma, dendrite, and axon). The model can reproduce the excitable properties of UBCs in current-clamp and voltage-clamp modes. Attempts at modeling the response to mossy fiber inputs are ongoing. This model confirms the primary role of the aforementioned
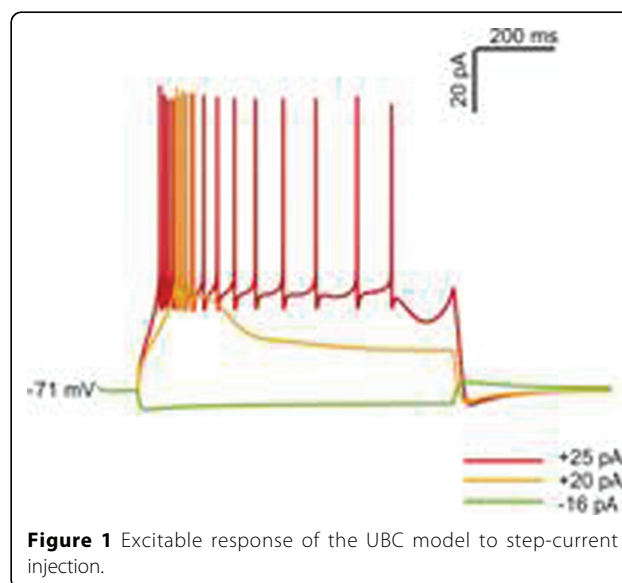


**Figure 1** Excitable response of the UBC model to step-current injection.

currents in UBC's electroresponsiveness. The model will also be a valuable tool for investigating the UBC's function in the cerebellar network.

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### References
1. Rossi DJ, Altford S, Mugnaini E, Slater NT: **Properties of transmission at a giant glutamatergic synapse in cerebellum: the mossy fiber-unipolar brush cell synapse.** *J. Neurophysiol* 1995, **74**(1):24-42.
2. Diana MA, Otsu Y, Maton G, Collin T, Chat M, Dieudonné S: **T-type and L-type Ca2+ conductances define and encode the bimodal firing pattern**

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of vestibulocerebellar unipolar brush cells. *J Neurosci* 2007,
**27**(14):3823-3838.

3.  Russo MJ, Yau HJ, Nunzu MG, Mugnaini E, Martina M: **Dynamic
    metabotropic control of intrinsic fring in cerebellar unipolar brush cells.**
    *J Neurophysiol* 2008, **100**(6):3351-3360.
4.  Ruigrok TJH, Henshroek RA, Simpson JI: **Spontaneous activity signatures of
    morphologically identified interneurons in the vestibulocerebellum.** *The
    Journal of Neuroscience* 2011, **31**(2):712-724.