Hodgkin-Huxley models of *C. elegans* neurons: from ion currents to complex neuronal dynamics

Martina Nicoletti [a,b], Alessandro Loppini [a], Letizia Chiodo [a], Viola Folli [b], Giancarlo Ruocco [b], Simonetta Filippi [a]

[a] Campus Bio-Medico University, Rome, 00128, Italy
[b] Center for Life Nano Science@Sapienza-Istituto Italiano di Tecnologia, Rome, 00161, Italy
e-mail: m.nicoletti@unicampus.it

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Caenorhabditis elegans is a small nematode widely used as a model organism for developmental biology, drug screening, and human disease studies. Its nervous system, made up of only 302 neurons, is fully characterized in neurons number and connetome, establishing the ideal framework for understanding simple, yet realistic, neuronal systems. Despite such simplicity, much is still unknown about inhibitory or excitatory nature of specific synaptic transmission. Indeed, electrophysiological characterization of single neurons is particularly challenging due to the small size of the nematode neurons. In this context, detailed biophysical models of single neurons could help to elucidate the molecular mechanisms at the basis of signal generation, integration, and transmission. In this work, we present a Hodgkin-Huxley model of ion currents involved in *C. elegans* neurons activity. We further combine such models to simulate the electrical activity of the chemosensory AWC^{ON} and of the motor RMD neurons, two of the most studied neurons in *C.elegans*, displaying prototypical dynamics of neuronal activation. Our models properly replicate the experimental whole-cell recordings for the two cells. We analyze in detail the ion currents role both in wild type and in knockout in silico neurons; thereby highlighting their role in the generation of graded regenerative plateau responses of the two neurons. Moreover, we analyze in detail the role of T-type calcium currents and passive membrane properties in shaping the nematode neuronal responses. Our analysis identified the existence of different dynamical regimes in the neuronal activity which includes bistable regimes and sustained oscillatory solutions. Our results not only provide a detailed electrophysiological and biophysical description of the nematode neuronal activity but also constitute the basis for single cell and multi-cells networks investigations and predictions, opening new scenarios in the *in silico* modeling of *C.elegans* neuronal system.

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