

MODELING THE HODGKIN-HUXLEY NEURON TO DETERMINE NEURONAL ENERGY CONSUMPTION EFFICIENCY AND OXYGEN CONSUMPTION VALUES

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ABSTRACT

Understanding neuronal structure and function is essential to studying the human brain. The goal of this project was to create a model of human brain neurons that accurately reflects neuronal function, energy consumption, and oxygen consumption. Extensive work has been performed on the Hodgkin-Huxley model of neurons to accurately model neuronal firing. This study focuses on the creation of a model of the Hodgkin-Huxley neuron in MATLAB with the assistance of the DynaSim toolbox. This model was used to compute values and using another model the energy efficiency of the neuron was calculated and related to oxygen consumption, which then corresponds to Blood Oxygenation Level Dependent (BOLD) imaging in fMRI. The results of this study provide detailed visual and technical information about how the brain neurons function, which is crucial to the further development in brain imaging techniques and to further our understanding of why and how our complex brains function.

Keywords: Hodgkin Huxley, Neuron, Model, MATLAB, Metabolic, BOLD

INTRODUCTION

From 1946 to 1952, Alan Hodgkin and Andrew Huxley developed what is now known as the Hodgkin Huxley model [1]. The Hodgkin-Huxley neuron model accurately describes and predicts the depolarization of a neuron. Hodgkin and Huxley developed this model by conducting experiments on the neuronal axon of the giant squid. The giant squid axon was used because it is a very large neuronal axon, up to 1 mm in diameter. The squid axon was also an ideal neuron to work with because it is a relatively simple system [2]. To study the neuron, they inserted a capillary electrode into the squid axon to record the potential difference across the axon membrane. Their experimentation resulted in success, and Hodgkin and Huxley were able to record the intracellular action potential. After many more experiments with the squid axon, their work eventually culminated in a mathematical