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Changing Internal Ion Concentrations Effect on Speed of Action Potential Propagation using HH model in Neuron

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# INTRODUCTION

The Hodgkin Huxley model is a set of equations that describes the behavior of action potentials in neurons. Physiologically, this translates to the set of conditions under which ion channels are likely to open or close, and the dynamics of the gate states. Abstracting the ion channels into a parallel RC circuit with capacitance associated with the membrane itself, variable conductance that is dependent on time and membrane potential, and the Nernst equilibrium potentials of primarily sodium and potassium ions. The standard sodium intracellular and extracellular concentrations are 12mEq/L and 140mEq/L, respectively1.

The required voltage to stimulate an action potential produced by the Hodgkin-Huxley model will be decreased as the ratio of sodium concentration outside the cell to inside the cell increases. By modifying the intra and extracellular concentrations of sodium or potassium ions, we can change the Nernst equilibrium potentials and thus the resting membrane potential of the cell. This, in turn, may affect the kinetics of ion channels opening and closing, thus potentially affecting both the time constants associated with the action potential and the probabilities at which the m, n, and h gates open and close, since they are influenced by the membrane potential. We expect that increasing the intracellular sodium concentration with respect to the extracellular sodium concentration will increase the stimulation voltage necessary to create an action potential, since membrane voltage will decrease as the sodium equilibrium potential decreases.

Further, changing the relative concentrations of ions will change the Nernst potential.2 When the sodium concentrations are higher, the morphology of the action potential. It will increase the activation rate of the activation gates to shorten the refractory period.

# Methods

We will perform simulations using NEURON to vary the intracellular sodium concentration of an electrically small cell. The intracellular sodium will be measured between 6mEq/L and 24mEq/L in increments of 2mEq/L. The extracellular concentration will stay constant at 140mEq/L. We will stimulate between -70mV and 30mV in increments of 10mV. This will be used to determine the minimum voltage required to yield an action potential (threshold voltage). An action potential is defined as when the stimulus yields a non-graded potential. To isolate the effect of changing the Nernst equilibrium potential we will first look at the change in the Na conductance, then the dynamics of the m, n, and h gates. Ultimately, we will compare the currents over time for the different setups stimulated at threshold voltages. We will show plots of m, n, and h gates to show the full effect.

# Results

hjbbjh

# Discussion

dsdf

# Conclusion

Conclusion stuff

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