# CALIFORNIA STATE SCIENCE FAIR
# 2017 PROJECT SUMMARY

**Name(s)**

Alexis Chirco; Olivia Kim

**Project Number**

**S0804**

**Project Title**

## Simulating the Effects of Alzheimer's Disease in the Hippocampus: Effects of Change in Ion Equilibrium and Acetylcholine

**Abstract**

**Objectives/Goals**

The purpose of this project was to create a simple computational neuron model that simulated the hippocampus's theta wave output in response to changes seen in the progression of Alzheimer's disease.

**Methods/Materials**

In order to change the equilibrium potentials of Na+ and K+ ions and applied acetylcholine amperage as a proxy for acetylcholine neuron connectivity to produce theta waves, variables, synapses, loop system, and spike and state monitors to track voltage were implemented into the Brian2 software in Python. Before writing the code for the model, importation of the previous models for the neurons and synapses was needed to run this model so stimulated neurons behaved based on previously done experiments.

**Results**

Ultimately, the data shows that as the equilibrium potential of sodium increases and the equilibrium potential of potassium decreases (becomes more negative) simultaneously, the frequency of the theta waves tends to increase. This trend holds true for both minor and extreme changes to the ENa and EK, but the more extreme the change is, the greater the frequency of theta is. As for the data shown in Part Three, the greater the applied amperage of acetylcholine, the greater the theta frequency while less amperage results in a lower frequency.

**Conclusions/Discussion**

In the end, the hypothesis was not supported by the data collected. The results showed that the greatest theta wave frequency was produced when the equilibrium potential of sodium (ENa) was increased by an ample increment, specifically from 55 to 85 millivolts. This change resulted in a frequency of 7.400 ± 1.350 Hz, which was a 68.18% increase from the control result. Furthermore, the exact opposite of what was hypothesized, or increasing the ENa and decreasing the equilibrium potential of potassium (EK), produced relatively large results at 5.700 ± 1.059 Hz. By and large, the data showed that individually increasing the ENa always increases theta frequency while individually decreasing the EK always decreases theta frequency. The reason why the results occurred in this manner is most likely due to the fact that increasing ENa excites the cell while decreasing EK inhibits the cell.Further research should most definitely be conducted on how to create a highly accurate computational hippocampus/neural model. Also,research should be conducted on how cell death affects the brain during the progression of Alzheimer#s.

**Summary Statement**

We simulated the effects of AD when sodium, potassium and acetylcholine amerage were modified.

**Help Received**

We programmed and performed the simulation by ourselves but received guidance from Conor Cox, a graduate student in the department of Neuroscience at UC Irvine.