Student Project Proposal: Modelling of an *in vitro* neuromodulatory co-culture system

Our lab creates and studies *in vitro* directional neuronal circuits of hippocampal neurons (Figure 1 A, B). Each node contains a few dozen neurons that are interconnected as well as connected between the neighbouring nodes. We also have a simulation that reproduces this circuits (Figure 1). In the simulation, every node contains three neurons modelled as Hodgkin-Huxley neuron somas, which are interconnected and also connected with the other nodes. The connection is random to some extent. Both biological and simulated networks we stimulate with different stimulation patterns, meaning introducing the current on the locations between the nodes.

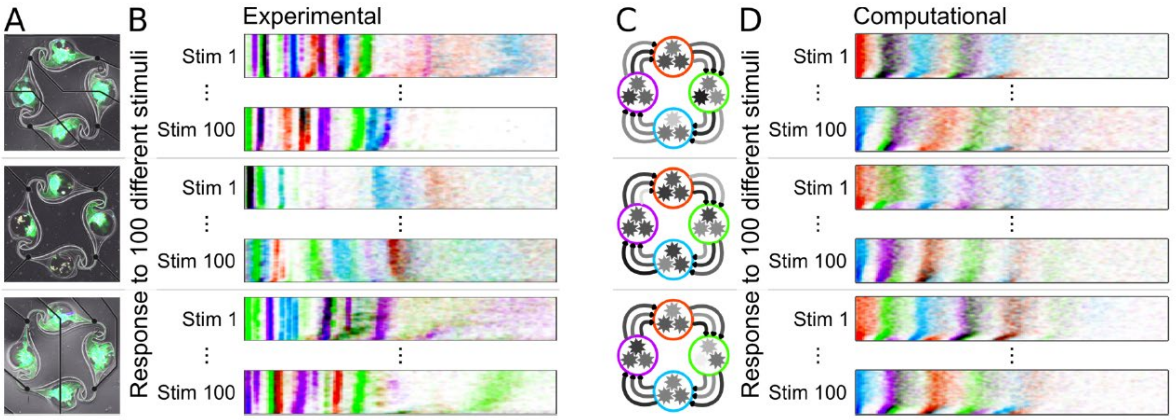

Figure 1: A: *In vitro* 4 node neuronal circuits; B: Recorded responses after stimulation; C: Simulation circuit; D: Simulated response

The next step is to introduce these networks to neuromodulatory compounds such as dopamine to study the changes is in the network behaviour (plasticity effects, activity patterns, spike timings…). This we do by adding extra 4 nodes with dopaminergic neurons. Each of these connects to one of aforementioned hippocampal nodes (Figure 2).

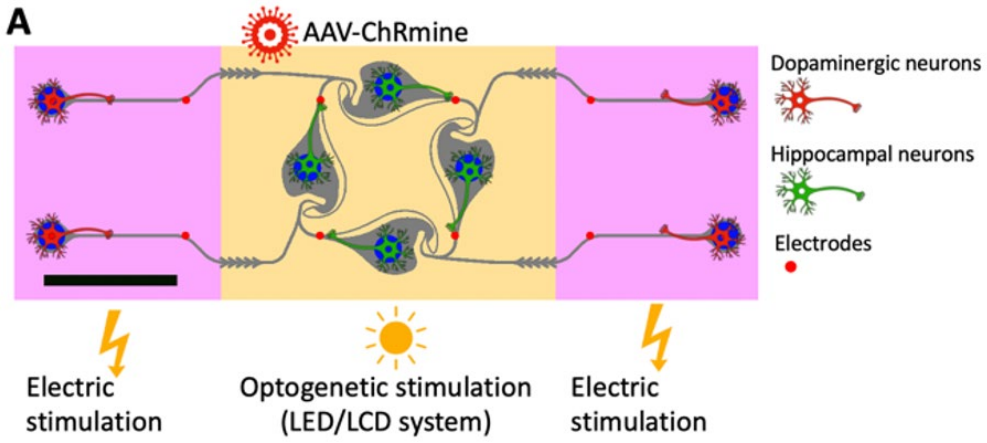

Figure 2: Co-culture (dopaminergic and hippocampal) system scheme

Student would create and/or upgrade the existing simulation by adding the influence of dopaminergic neurons on the existing 4 node hippocampal neuronal circuit. Since this is a problem that includes various parameters and optimization, student would use machine learning approaches to find the right choice of parameters that would satisfyingly mimic the *in vitro* behaviour.