**Computer lab 2**

**I.Dendritic Computation (9 points)**

In the spatial-extended neurons, action potentials initiated in the axon can backpropagate into dendritic trees. Experiments show that backpropagating action potentials (bAPs) have significant physiological functions in neural signal processing and inter-neuron communications.

i. **bAPs only**. Show the L5 pyramidal cell (Hay, 2011) can generate bAPs on apical dendrites with somatic current injection. Remove all sodium channels in proximal dendrites and give the same current injection, what happen to the bAPs on apical dendrites? What is the principal mechanism of bAPs?

ii. **Synaptic inputs only**. Place a single synapse (exp2syn\_exc) on the L5 pyramidal cell model, how the synaptic input location (e.g. soma, basal/apical dendrite shafts, spines) influence the voltage responses at the input site and the soma? How about the case when the synaptic inputs are clustered (n synapses at one location, n=5,10,20)?

iii. **bAPs and clustered synaptic inputs.** Apply both the somatic current injection and clustered synaptic inputs to the L5 pyramidal cell, how does **the somatic/input site’s voltage response** differ from previous results when only bAPs / synaptic inputs exist? Interpret your result from the aspect of the (in)activation of ion channels.

**II． Discussions (6 points)**

You are encouraged to draw upon the principles and mechanisms you've learned in lab 1/2 and to propose hypotheses, experimental designs, or model modifications to explore any of the following topics, but not limited to, in greater depth:

**1. Ion Channelopathies and Neurological Disorders:**

* **Background**: Introduce ion channelopathies, which are disorders caused by the dysfunction of ion channels, and explain their impact on neural function.
* **Exploration**: Students could explore specific diseases such as Epilepsy, Migraine, or certain types of Ataxia, and discuss how mutations in ion channels contribute to these disorders.(Hints: check mutations of Na+, K+, or Ca2+ in any of these diseases)
* **Modeling and Simulation**: Students could attempt to model the altered ion channel dynamics in NEURON and observe how these alterations could lead to disease phenotypes.

（例如，浙大的胡海岚老师有一系列的关于抑郁症的工作，这些疾病都和离子通道，受体密切相关 ）

**2. Neural Coding and Information Processing:**

* **Background**: Introduce the concept of neural coding, the way in which the nervous system converts sensory information into patterns of electrical activity.
* **Exploration**: Students could explore how the Hodgkin-Huxley model and dendritic computations contribute to neural coding and information processing.(Hints: check Na+, Ca2+, dendritic structures)
* **Modeling and Simulation**: Students could simulate different encoding schemes or dendritic processing strategies in NEURON, analyzing how these models capture the essence of neural information processing.

For the discussion part, you need to prepare a PPT (8 mins), covering background, methods, and results.

You are also welcome to propose your own project! 😊