Presentation Topic:

Hodgkin–Huxley (HH) Model and Disease – Myotonia and Hyperkalemic Periodic Paralysis (HPP)

Name: Ritik Dubey (22MS208)

Summary:
In this presentation, I discussed one of the foundational papers in neuroscience—the Hodgkin–Huxley (HH) model—and used it to explain two channelopathies: Myotonia and Hyperkalemic Periodic Paralysis (HPP). I began by introducing the basic electrical analogies where ion channels behave like resistors and the cell membrane behaves like a capacitor. I then described how reversal potentials arise for each ion channels and why they matter for membrane dynamics.
After a brief historical context, I outlined the original HH experiments and the theoretical formulation of membrane potential along with the time-dependent gating variables, and demonstrated the successful simulation of the action potential.

I then introduced both diseases and provided the theoretical reasoning for how they can be modelled within the HH framework using the Two-Compartment Model. Finally, I explained the obtained voltage traces biophysically and concluded by showing that the HH model not only reproduces normal action potentials but also helps explain Myotonia and HPP. These disorders arise due to defects in sodium-channel inactivation, which lead to prolonged inward Na^+ current and consequent long-duration accumulation of K^+ in the T-tubule lumen of muscle fibers, ultimately causing the pathological excitability seen in both conditions.

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