Membrane currents and Hodgkin–Huxley gate kinetics — review sheet

Use this after attempting the worked examples and practice. Explain each claim in words before calculating.

Key ideas

- Current balance controls voltage rate under a declared sign convention.
- An ion current needs both conductance and a driving difference.
- m, h and n are fractions; their combinations determine conductances.
- A voltage clamp fixes rates; a free spike couples gates and voltage.
- Equal pulse timing and initial conditions support a controlled comparison.
- Numerical accuracy and biological validity require different evidence.

Common errors and repairs

Treating h as sodium current. h is a dimensionless availability fraction; current also needs m, a maximal conductance and V - E_Na.

Calling a clamped-voltage gate trace a predicted voltage spike. The clamp supplies the voltage. A free-voltage experiment must solve current balance.

Assuming bounded gates make a coarse trajectory accurate. Bounds check admissibility. Compare smaller steps and independent references for accuracy.

Retrieve without your notes

- What is current through a pathway at its reversal potential?
- For alpha = beta = 1/ms, what is the equilibrium gate fraction?
- Does doubling membrane area at fixed density double the voltage input per area?

Readiness check

- Use a stated current sign convention to predict whether membrane voltage rises or falls.
- Interpret m, h and n as gate fractions and connect them to conductance.
- Distinguish a voltage clamp from a freely evolving voltage.
- Compare two controlled stimuli and identify positive feedback and recovery.

- Separate numerical checks from evidence about an actual neuron or heart cell.