Home work set 1

Examine general properties of electrically excitable cells as revealed by the Hodgkin-Huxley model of the giant axon of the squid.

The following set of equations was used by HH to summarize the behaviors of channels in a squid axon.

$$I = C_m \frac{dV}{dt} + \bar{g}K * n^4 (V - V_K) + \bar{g}Na * m^3 h (V - V_{Na}) + \bar{g}L (V - V_L)$$

$$\frac{dn}{dt} = \alpha_n (1 - n) - \beta_n n$$

$$\frac{dm}{dt} = \alpha_m (1 - m) - \beta_m m$$

$$\frac{dh}{dt} = \alpha_h (1 - h) - \beta_h h$$

Where

$$\alpha_n = \frac{-0.01(V + 50)}{e^{-0.1(V+50)} - 1} \qquad \alpha_m = \frac{-0.1(V + 35)}{e^{-0.1(V+35)} - 1} \qquad \alpha_h = 0.07 e^{-0.05(V+60)}$$

$$\beta_n = 0.125 e^{-0.0125(V+60)} \qquad \beta_n = 4 e^{-(V+60)/18} \qquad \beta_h = \frac{1}{e^{-0.1(V+30)} + 1}$$

$$\bar{g}K = 36 \qquad \bar{g}Na = 120 \qquad \bar{g}L = 0.3 ms/cm^2$$

$$V_K = -72 \qquad V_{Na} = 55 \qquad V_L = -50mV$$

$$n_0 = 0.32 \qquad m_0 = 0.057 \qquad h_0 = 0.86$$

$$C_m = 1 \mu F/cm^2$$

$$V_0 = -60mV$$

A. Simulate HH equation using MABLAB and explore the implications of the model of the following attributes of electrically excitable cells

1. All-or-non properties and threshold
2. Refraction period
3. The strength-duration relationship
4. Accommodation
5. Repetitive activity

B.

6. What would you predict the shape of the action potential to be in a squid axon if you could specifically block K channels?
7. The proteolytic enzyme Pronase has been used to block the Na channel inactivation. What effects would this block have on the shape of action potential?
8. Which parameters determine the duration of action potential? Find a set of parameters in which you can reduce the duration of action potential without reducing the amplitude of action potential.