Biol635/Math635/Biol432/Math430
Fall 2022
.
Assignment 2

Answer the following questions.

- Justify your answers.
- Explain your results.
- Provide the necessary calculations in a clear way.
- Provide the codes you used (if any).

Question 1

Calculate the equilibrium (reversal) potentials for the following ions at a temperature of 20° C.

(a) K^+, $[K^+]_{out}$= 5 mmol/L, $[K^+]_{in}$= 150 mmol/L.
(b) Na^+, $[Na^+]_{out}$= 150 mmol/L, $[Na^+]_{in}$= 15 mmol/L.
(c) Cl^-, $[Cl^-]_{out}$= 125 mmol/L, $[Cl^-]_{in}$= 10 mmol/L.
(d) Ca^{2+}, $[Ca^{2+}]_{out}$= 2 mmol/L, $[Ca^{2+}]_{in}$= 0.0002 mmol/L.
(e) What is the effect of increasing the temperature to 25° C on these equilibrium potentials.
(f) Plot graphs of E_{Na}, E_K, E_{Ca} and E_{Cl} as a function of temperature in the range 10° C to 40° C.

Question 2

(a) Consider an ion X^+ at 20° C. What is the concentration relation $[X^+]_{out}/\ [X^+]_{in}$ necessary to maintain a resting membrane potential V = -60 mV?
(b) How is this value affected when the temperature is increased to 25° C?

(c) Plot a graph of the concentration relation $[X^+]_{out}/\,[X^+]_{in}$ necessary to maintain a resting membrane potential V = -60 mV as a function of the temperature in the range 10° C to 40° C.

Question 3

Consider the following passive membrane equation

$$\tau \frac{dV}{dt} = -(V - E_L) + R\, I_{app} \tag{1}$$

with $V(0) = E_L$, $R = 100\, M\Omega$, $C = 100\, pF$, $I_{app} = 0.25\, nA$ and $E_L = -60mV$.

(a) Calculate the value of τ.

(b) Calculate the value of the term $R\, I_{app}$.

(c) Calculate, if possible, the time it takes the voltage to reach $V = -50\, mV$.

(d) Calculate, if possible, the time it takes the voltage to reach $V = -30\, mV$.

Question 4

Write a code to solve numerically eq. (1) or adapt the template code provided in the course website. Simulate eq. (1) for the parameter provided in Question 3.

Note: The axis should be labeled correctly and the fonts should be large enough (suggested: "fontsize" = 24).