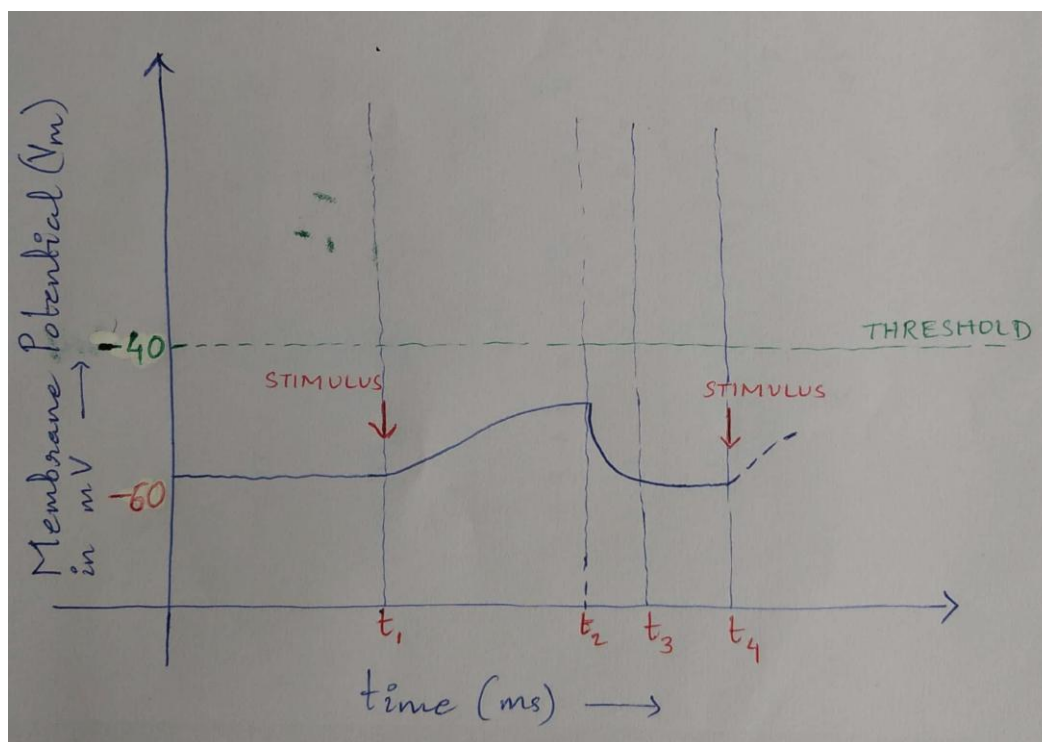


BB101 Tutorial Physiology Module

Q1. A mammalian excitable cell at room temperature (37°C) has its membrane potential (V_m) determined by two ions as given in the table. The plot of V_m with respect to time has a form as shown in the figure. At the instant t_1 , an external stimulus applied to the cell membrane caused a change in the resting membrane potential due to a change in the permeability of the membrane to Na^+ and K^+ ions. In the following context, study the information given in the table and figure to answer the questions that follow (Use $R = 8.314\text{ J/K/Mol}$; $T = \text{absolute temperature}$; $z = \text{valency}$; $F = 96500\text{ C/Mol}$).

Parameter	Intracellular	Extracellular
$[\text{K}^+]$ ion	180 mM	10 mM
$[\text{Na}^+]$ ion	20 mM	145 mM
$\alpha = (P_{\text{Na}}/P_{\text{K}})$	Value at time t_4 is 5 times the value at rest. P_{Na} = permeability of cell membrane to Na^+ ions and P_{K} = permeability of cell membrane to K^+ ions	
Peak amplitude of action potential (AP)	+30 mV	



- (a) Calculate the Nernst/ equilibrium potential of Na^+ and K^+ ions.
- (b) Which of the two ions is closer to resting membrane potential ? What does this signify ?
- (c) Calculate the value of α at rest.
- (d) At the time instant t_4 a second external stimulus was applied to the cell membrane that led to a change in V_m (dotted right end of the graph) such that $\alpha_{t_4} = 5$ times the value at rest. Calculate the value of the membrane potential corresponding to the stimulus applied at t_4 .
- (e) Complete the dotted right end of the graph taking into account the values calculated by you in (d).
- (f) In order to attain the value of V_m calculated in (d), what should be the change in temperature (in degree celsius) of the cell ? Consider the situation where $P_{\text{Na}}/P_{\text{K}}$ does not change with time and a change in the temperature is the only mechanism via which V_m can be changed.
- (g) In order to attain the value of V_m calculated in (d), what should be the $[\text{Na}^+]$ ion concentration in extracellular medium? Consider the situation where $P_{\text{Na}}/P_{\text{K}}$ as well as other parameters do not change with time and a change in Na^+ ion concentration is the only mechanism via which V_m can be changed.
- (h) Are the mechanisms suggested in (f) and (g) for changing V_m desirable as compared to a change in the permeability of cell membrane to ions. Give reasons to justify your answer.