

$$C_m \frac{dV}{dt} = -i_L - i_{Na} - i_K + i_e, \quad i_L = \bar{g}_L (V - E_L) \quad (1)$$

$$i_{Na} = \bar{g}_{Na} \cdot m^3 \cdot h (V - E_{Na}) \quad i_K = \bar{g}_K n^4 (V - E_K) \quad (2)$$

Substitute into main dyn eq:

$$\Rightarrow C_m \frac{dV}{dt} = -(\bar{g}_L (V - E_L)) - (\bar{g}_{Na} \cdot m^3 \cdot h (V - E_{Na})) - (\bar{g}_K \cdot n^4 (V - E_K)) + i_e$$

$$C_m \frac{dV}{dt} = -\bar{g}_L V + \bar{g}_L E_L - \bar{g}_{Na} \cdot m^3 \cdot h \cdot V + \bar{g}_{Na} \cdot m^3 \cdot h \cdot E_{Na} - \bar{g}_K \cdot n^4 \cdot V + \bar{g}_K \cdot n^4 \cdot E_K + i_e$$

$$\frac{dV}{dt} = \left(\frac{1}{C_m} \right) -V \left(+\bar{g}_L + \bar{g}_{Na} \cdot m^3 \cdot h + \bar{g}_K \cdot n^4 \right) + \bar{g}_L E_L + \bar{g}_{Na} \cdot m^3 \cdot h \cdot E_{Na} + \bar{g}_K \cdot n^4 \cdot E_K + i_e$$

$$\Rightarrow \frac{dV}{dt} = \left(\frac{\bar{g}_L + \bar{g}_{Na} \cdot m^3 \cdot h + \bar{g}_K \cdot n^4}{C_m} \right) \cdot \left(\frac{\bar{g}_L E_L + \bar{g}_{Na} \cdot m^3 \cdot h \cdot E_{Na} + \bar{g}_K \cdot n^4 \cdot E_K + i_e}{\bar{g}_L + \bar{g}_{Na} \cdot m^3 \cdot h + \bar{g}_K \cdot n^4} \right) = V$$

$$\text{if } \tau_{eff}(t) = \frac{C_m}{(\bar{g}_L + \bar{g}_{Na} m^3 h + \bar{g}_K n^4)}$$

$$\text{then, } \frac{1}{\tau_{eff}(t)} = \frac{\bar{g}_L + \bar{g}_{Na} m^3 h + \bar{g}_K n^4}{C_m} \quad \checkmark$$

And substituting
= V_{∞}^{eff}

$$\Rightarrow \frac{dV}{dt} = \frac{1}{\tau_{eff}} [V_{\infty}^{eff} - V]$$