Excitable Cell Physiology -- Problem Set #2:
Membrane Potentials and the Voltage Clamp

Animal Physiology
Fall 2015

1. Assume that a cell is absolutely **impermeable to Na^+** at rest and it is **freely permeable to K^+ and Cl^-**. Ignore all other ions. Here are the concentrations of each ion:

$[K^+]_{in}$ = 240 mM $[K^+]_{out}$ = 10 mM

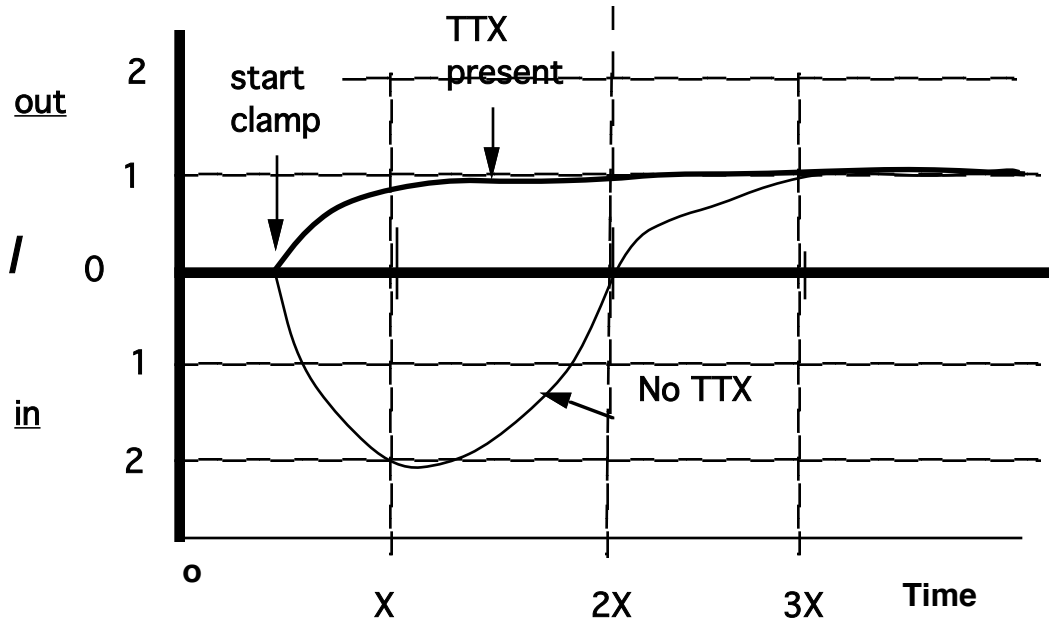
$[Cl^-]_{in}$ = 15 mM $[Cl^-]_{out}$ = 360 mM

$[Na^+]_{in}$ = 20 $[Na^+]_{out}$ = 145.6 mM

The temperature is 20^o C

Calculate: i) E_{K^+}; ii) E_{Na+} ; iii) resting E_m

2. The cell is now voltage clamped at Em = - 40 mV -- a value well above its threshold. Here are the results of two runs, one with tetrodotoxin (TTX), and the other without:



(a) Calculate G_{K^+} and G_{Na^+} for the three times x, 2x and 3x. (Don't worry about units).

(b) In this clamp experiment, what is the membrane capacitive current (I_C) at time 3x? Would it be the same in a non-clamped situation -- you need not give the actual value of I_C in this case, just the relative value? Explain your answer in no more than 3 sentences.

(c) Using the values you calculated for *G* above the ionic concentrations given in question 1; reconstruct an action potential (E_M vs. time) for the cell. Obviously, this refers to the unclamped condition. Note that you will make this reconstruction with a total of three values (talk about sampling!).