

HOMEWORK # 1

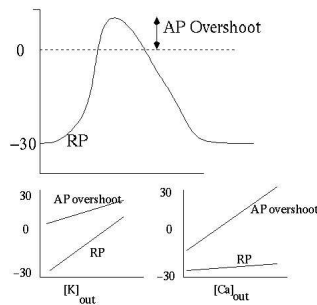
1. Page 2 of passive handout - probs 1,2,3
2. Page 6; 1-4
3. page 16; 1,2
4. page 19 bottom
5. Derive the differential equation for the potential of an isopotential sphere that is 100 microns in diameter. Assume that the resting potential is -70 mV, the specific capacitance is $1 \mu F/cm^2$, the resistivity is $10000 \Omega-cm^2$.
6. Either analytically or numerically, plot the amplitude response of the following model:

$$20 \frac{dV}{dt} = -V(t) + 10 \sin \omega t$$

as a function of ω . That is, plot the maximum amplitude of the steady-state solution.

7. Consider a cable with electrotonic length L and a sealed end at $x = L$. Suppose $V(0) = V_0$. Show that the input conductance at $X = 0$ is

$$G_L = G_\infty \tanh(L).$$



8. (From Johnston & Wu) The paramecium has a resting potential (RP) and an action potential (AP) similar to many neural potentials. In typical pond water, the figure shows the AP and the RP for the cell. If one varies the extracellular potassium or the extracellular calcium, the results are shown in the lower part of the figure. Assume that the cell is only permeable to these two ions and water. Answer these:
 - (a) In the resting state which is true: $P_K > P_{Ca}$, $P_K = P_{Ca}$, or $P_K < P_{Ca}$?
 - (b) What about at the peak of the AP?

- (c) Compared to the ionic concentrations of pond water, is $[K]_{in}$ greater than, less than or equal to $[K]_{out}$? Explain.
- (d) Answer the same for calcium
- (e) When the posterior end of the organism is mechanically tapped, the membrane transiently hyperpolarizes. What permeability changes might be responsible?