1) a) They are seeing <u>anodal</u> Stimulation when they pace the <u>LV</u>. This could be either make or break excitation.

b) The wave that was stimulated by the <u>RV cathode</u> is just repolarizing at the anode when the LV is paced. The LV anodal ~~wave~~ wave collides with the RV cathodal wave and unidirectional block occurs resulting in reentry. Increasing the RV tip-to-ring distance would increase the coupling interval for unidirectional block.

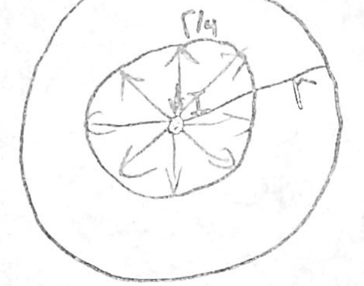
c) Increase the surface area of the ring so that $\vec{J}$ is lower. Since $\vec{J} = \sigma \vec{E}$, $\vec{E}$ will be lower and $A = \nabla \vec{E}$ will be lower. This will redue the likelihood of anodal stimulation.

2) a) The objective is to pace in the <u>excitable gap</u>. Without measuring precisely where/when that is, pacing faster ensures that a stimulus will eventually fall during the correct interval. For the same reason multiple pulses must be applied.

b) Multiple answers accepted

3)

$\rho = 50\ \Omega\text{-cm}$ $c = 4.2\ J/cm^3\,^\circ C$



Surface area $= 4\pi r^2$

$$\boxed{\vec{J} = \frac{I}{4\pi r^2}}$$

Since all current must exit the sphere. For $0 \le t \le d$

b) $\Phi = \frac{I_0}{4\pi\sigma r} \Rightarrow \Phi = \frac{I\rho}{4\pi r}$ $\vec{E} = -\nabla\Phi = \frac{-\partial}{\partial r}\left(\frac{I\rho}{4\pi r}\right)$

$= \frac{I\rho}{4\pi r^2}$ Alternatively: $\vec{E} = \rho\vec{J}$

Power $= V \cdot I$ (in watts) or $\vec{E} \cdot \vec{J}$ (in watts/cm^3)

$$\boxed{\vec{E} \cdot \vec{J} = \frac{I^2\rho}{16\pi^2 r^4}\ W/cm^3}$$

c) $\frac{I^2\rho d}{16\pi^2 r^4}$ = Energy into fluid volume over pulse duration (in J/cm^3)

So: $\boxed{\frac{I^2\rho d}{16\pi^2 r^4 c}\ ^\circ C}$

d) If I is a constant current source as described then nothing will change so long as $\rho \neq \infty$ in the charred region

e) This is different than in class because there the charring would limit the current and temp rise. This model doesn't account for limited output capability of the current source into a high impedance or the thermal conductivity of the solution.

5:

(a)

$$t_1 = \tau_m \ln\left(\frac{1}{1-\frac{Av_{th}}{IR_m}}\right) \tag{3}$$

$$t_2 = d + \tau_m \ln\left(\frac{IR_m}{Av_{th}}\left(1 - e^{-d/\tau_m}\right)\right) \tag{4}$$

$$\delta = t_2 - t_1 = d + \tau_m \ln\left(\left(\frac{IR_m}{Av_{th}} - 1\right)\left(1 - e^{-d/\tau_m}\right)\right) \tag{5}$$

$$\frac{\delta - d}{\tau_m} = \ln\left(\left(\frac{IR_m}{Av_{th}} - 1\right)\left(1 - e^{-d/\tau_m}\right)\right) \tag{6}$$

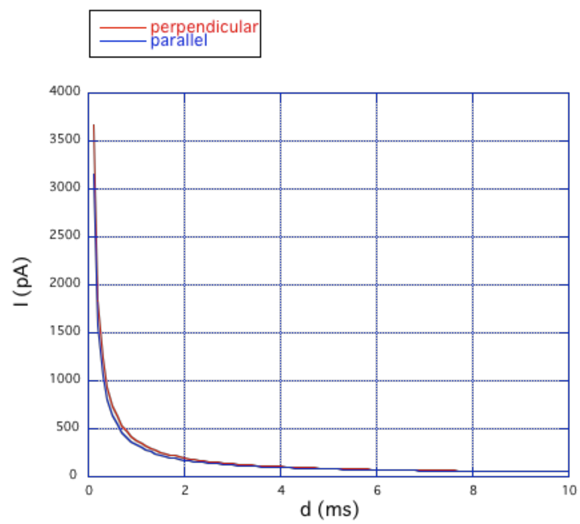
$$e^{(\delta-d)/\tau_m} = \left(\frac{IR_m}{Av_{th}} - 1\right)\left(1 - e^{-d/\tau_m}\right) \tag{7}$$

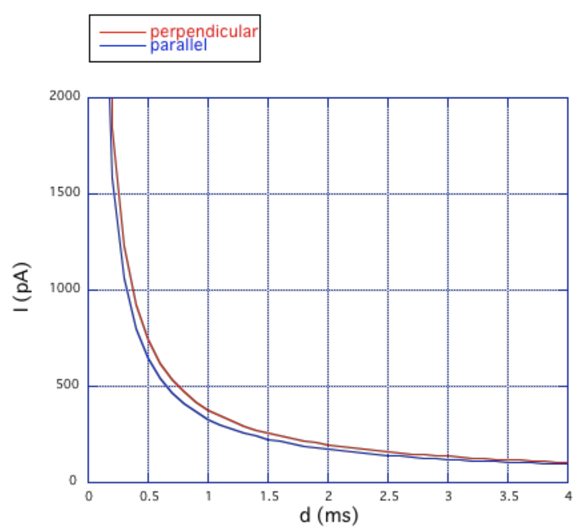
$$I = A\frac{v_{th}}{R_m}\left(1 + \frac{e^{(\delta-d)/\tau_m}}{\left(1-e^{-d/\tau_m}\right)}\right) = A\frac{v_{th}}{R_m}\left(\frac{1-e^{-d/\tau_m}+e^{(\delta-d)/\tau_m}}{1-e^{-d/\tau_m}}\right) \tag{8a}$$

$$= A\left(\frac{v_{th}}{R_m}\right)\left(\frac{1}{1-e^{-d/\tau_m}}\right) + A\left(\frac{v_{th}}{R_m}\right)\left(\frac{e^{(\delta-d)/\tau_m}-e^{-d/\tau_m}}{1-e^{-d/\tau_m}}\right) \tag{8b}$$

$$= A\left(\frac{v_{th}}{R_m}\right)\left(\frac{1}{1-e^{-d/\tau_m}}\right) + A\left(\frac{v_{th}}{R_m}\right)\left(\frac{e^{\delta/\tau_m}-1}{e^{d/\tau_m}-1}\right) \tag{8c}$$

(b)





(c)
v_m remains above v_{th} for a short interval after $t = d$, while decaying to zero. This is evident from the figure.

(d)
The values of I, with d = 1 ms, are 378.47 pA when δ = 1.5 ms and 330.13 pA when δ = 0 ms. Therefore, the ratio is 1.146, or 14.6% higher when activation time is factored in.