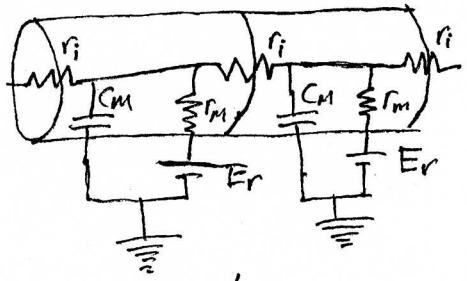
Equivalent Circuit (simplified model of a dendrite or axon)



r_i internal / longitudinal resistance

r_m membrane / axial resistance

C_M membrane capacitance

Er resting potential

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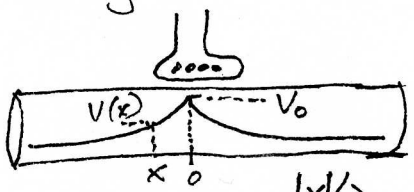
r_i inversely proportional to diameter of tube

r_m controlled by number of channels through membrane (also affected by myelin)

Er constant for a neuron type, u-65mV

C_m mostly depends on membrane thickness major function of myelin is to decrease

Passive spread along the tube



$$V(x) = V_o e^{-|x|/\lambda}$$

$$\lambda = \sqrt{r_m / r_i}$$

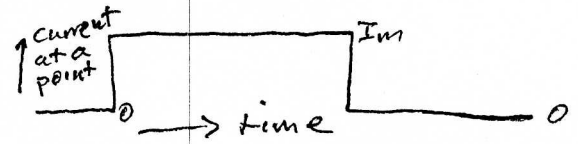
λ is called the characteristic length or space constant

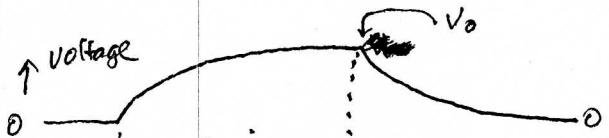
$$V(\lambda) = 0.37 V_o$$

— increase r_m or decrease r_i: λ gets larger

cells typically make λ large — enables integration over great distances

Passive spread in time (after a sudden change)





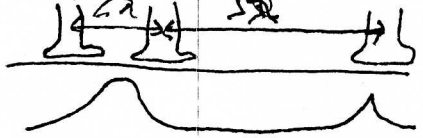
in here $V = I r_m (1 - e^{-t/\tau})$

out here $V = V_o e^{-t/\tau}$

$\tau = r_m c_m$ ← $V(\tau) = 0.37 I r_m$

— increase r_m or c_m: τ gets larger

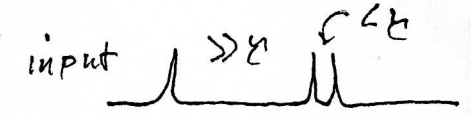
Space integration



peaks here add

this one doesn't

Time integration



this doesn't add

but these do

TRADEOFF: big τ enables long time integration (good for dendrites) small τ enables fast signal propagation