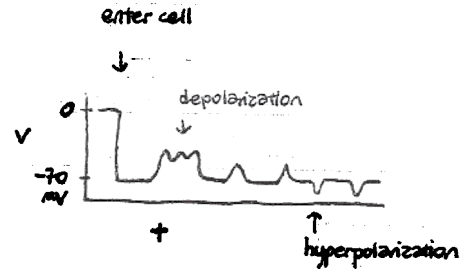
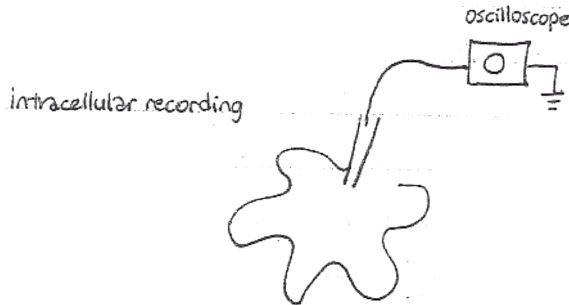


Lecture notes courtesy of Wyan-Ching Mimi Lee. Used with permission.

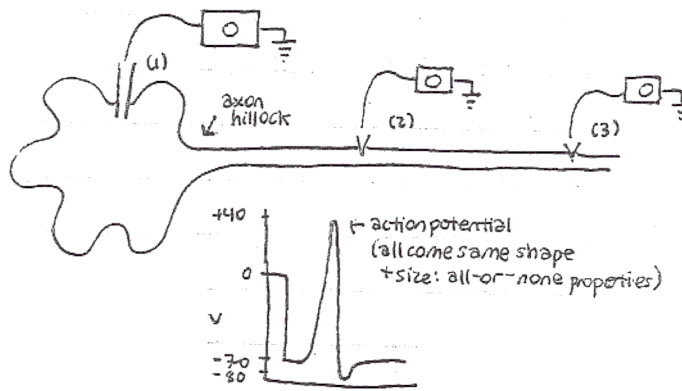
2/9/04

axon hillock - between cell body + axon



- some synapses depolarize, some hyperpolarize

- summation of depolarizations may depolarize membrane sufficiently to cause action potential



reading from (2) or (3): will be same, undiminished in size

- from 3m/s to 100m/s (not speed of light)

- unlike readings from (1), which do diminish in size as propagated

synaptic potentials

- Summation of ΔV at axon hillock to $-58mV$ (threshold) will give action potential

refractory period - time after action potential during which you can't get another action potential

relative refractory period - push harder, get "puny" action potential (smaller amplitude)

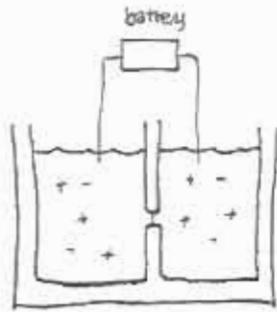
- axons usually $\sim 10\mu m$ in diameter; up to 1mm in giant squid axons

- Hodgkin + Cain (sp?) squished all cytoplasm to end of axon w/ rubber roller, squeezed out like toothpaste

- did flame photometry on squished out cytoplasm to see $[Na^+]$, $[K^+]$

- found more K^+ inside, Na^+ outside

- re-inflated axon with appropriate salt solution (no other cytoplasmic elements): got action potential (all in membrane)



2 salt water chambers, hole (~ 1/2 mm in diameter)
can point phospholipid across hole, form bilayer membrane

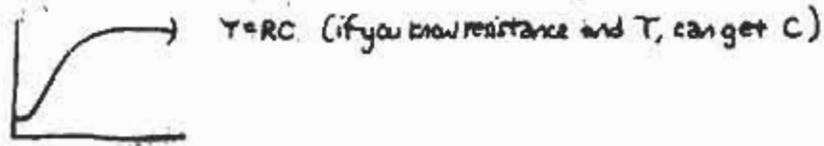
- salts in solution (Na^+ and Cl^- ?), apply voltage across membrane, measure conductance etc

R = ohms, resistance

g = conductance ($= \frac{1}{R}$), measured in siemens

- artificial membranes much less conductive than real ones with proteins

- put step voltage across membrane, will get to max w/ exponential decay

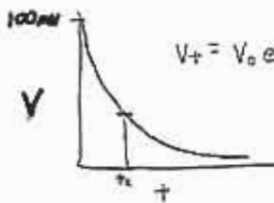


- C depends on area of plates and plate distance between them (putting in proteins will change resistance but not capacitance)

lipid bilayer



↑ protein (make hole lined w/ polar groups so ions can go through)

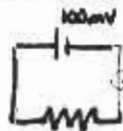


$$V_t = V_0 e^{-t/RC}$$

$$\frac{t}{RC} = \ln \frac{V_0}{V_t}$$

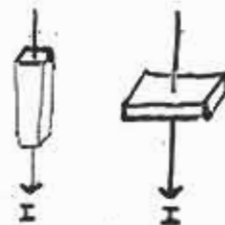
look at exponential decay after short circuit

for homework: know how to measure conductance, resistance, make circuit w/ ohm's law



$$V = IR$$

$$I = gV$$



how does property of resistor depend on shape?

(more resistance)



$$R = R_1 + R_2$$

resistance proportional to length

if same length, skinny more resistant than fat

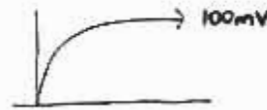
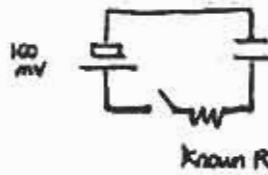
(because for like resistors in parallel)



$$R = \rho \frac{l}{A}$$

ρ ← cross section resistivity

- how do you measure capacitance in an RC system? charge or discharge



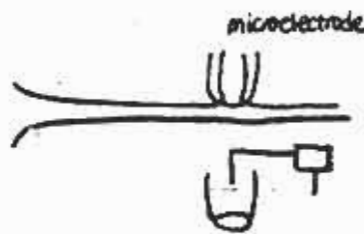
time it takes to get to max is measure of capacitance (know R & V)

$$V = V_{\infty} (1 - e^{-t/RC})$$

- neurotransmitter can bind ligand-gated channels, let Na^+ in (depolarize) or K^+ out (hyperpolarize)

action potential - Na^+ channels opened by voltage, depolarize axon, positive feedback depolarization until saturated, then channels close

patch clamp:



apply suction w/ microelectrode, form tight seal w/ membrane

tear patch away from axon
put voltage across membrane (-75 mV outside)
measure current

ion channels

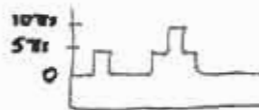
conductance

ion selectivity - Na^+

K^+

Cl^-

Ca^{++}



current is quantized

patch contains 1-3 of same channel,
see current caused by opening + closing of channels

quantization of channel conductances; all-or-none

gating

ligand (small molecules)

voltage

second messenger (phosphorylation eg by PKA or dephosphorylation)