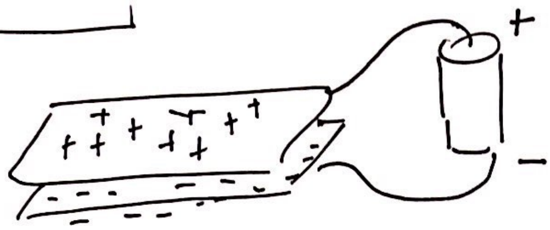
Boulder Lecture 11 SEP

CB1 11

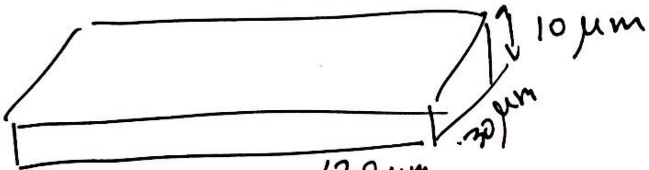


$$C \frac{dV}{dt} = I$$

$$C_{membrane} \frac{dV}{dt} = -I_{ion}$$

↑ by convention, inward current is negative

- mammalian ventricular myocyte

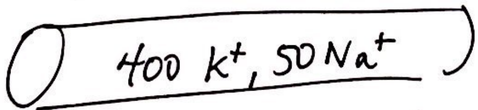


neurons are lonely bags of potassium

(Joke!)
Na & Cl are walking down the street

outside	inside
5 mM K^+	140 mM K^+
140 mM Na^+	10 mM Na^+
2 mM Ca^{++}	0.0001 mM Ca^{2+}

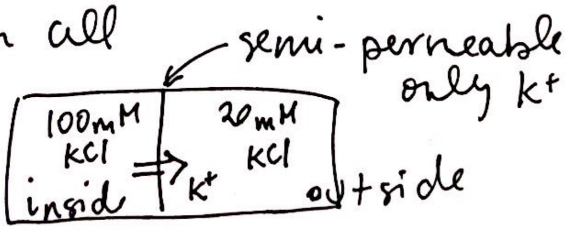
- SQUID GIANT AXON:



$20\,K^+$, $491\,Na^+$

↖ salty! lives in the sea

concentration cell

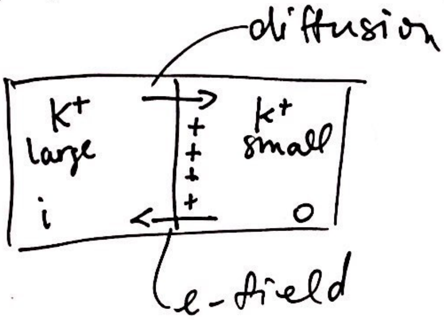


voltage diff creates an E-field that opposes K^+ flow

$$\mu = \mu^0 + RT \ln C + zFV$$

- RT ln C: diffusion
- zFV: electric field
- μ^0: "standard" electrochem potential
- R: gas const
- T: temp
- C: concentration
- z: # of charges
- F: Faraday's const.
- V: voltage

μ: want to move from higher to lower potential



at equillibrium

$$\mu_i = \mu_o$$

$$\ldots \quad zF(V_i - V_o) = RT(\ln C_o - \ln C_i)$$

$$\Rightarrow (V_i - V_o) = \frac{RT}{zF} \ln \frac{C_o}{C_i}$$

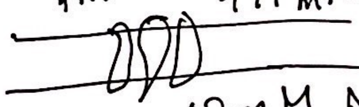
$(V_i - V_o)$ ≡ Nernst potential

E_x ← usually written like this

$V - E_x$ is the "driving force" for ion X

$$I_x = g_x (V - E_x)$$

~~inside~~ outside 491 mM Na^+



50 mM Na^+ inside

g_x: can depend on V & time!

if $V - E_{Na} > 0$ $\Delta\mu_{Na} > 0$ Na^+ moves out of the cell

if $V - E_{Na} < 0$ $\Delta\mu_{Na} < 0$

SQUID

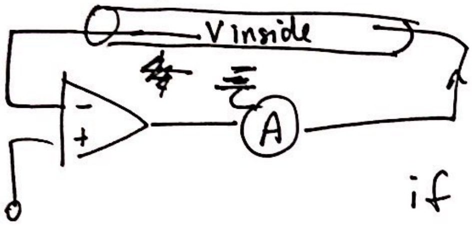
$E_{Na} = +55mV$
$E_K = -72mV$

CBI 2

$I_K = g_K (V - E_K)$

↑ what if you measure this?
still… I could change b/c
g changed <u>OR</u> V changed
difficult to separate!

⇒ voltage clamp!

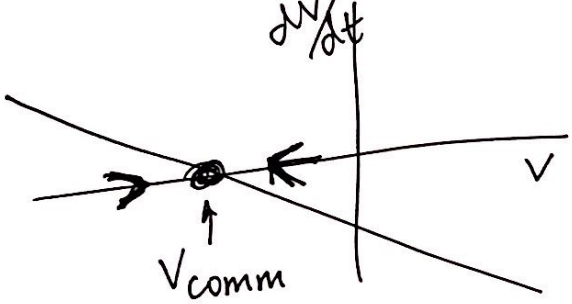


I ← measure

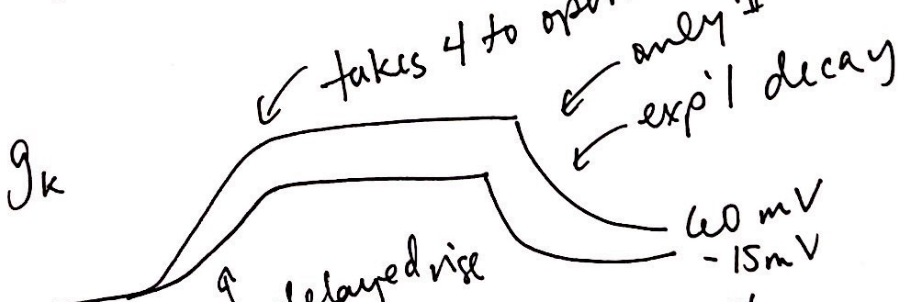
Vcomm

if $V_{comm} > V_i$
I depolarizes
if $V_{comm} < V_i$
I hyperpolarizes

1D dynamical system



CBI 3



$\sim (1 - e^{-t/\tau})^4$ ← a guess!!

$(1-n) \underset{\beta}{\overset{\alpha}{\rightleftharpoons}} n \qquad \frac{dn}{dt} = \alpha(1-n) - \beta n$

$n \equiv$ fraction of particles in "permissive state"