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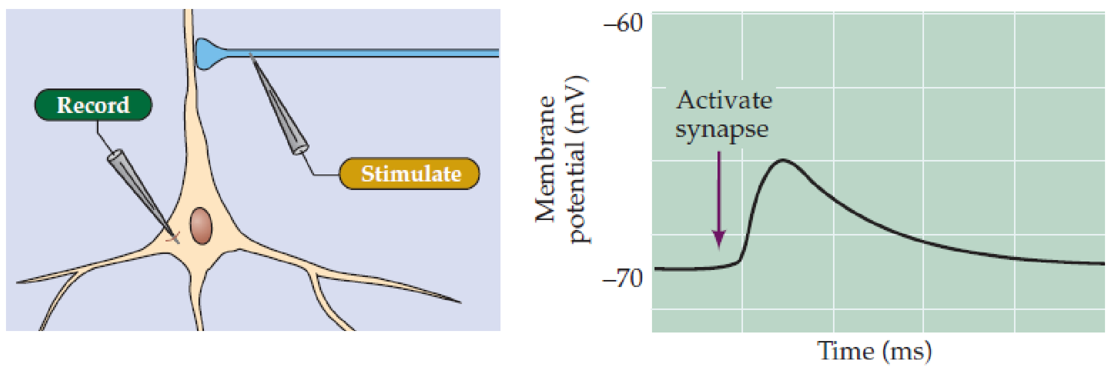
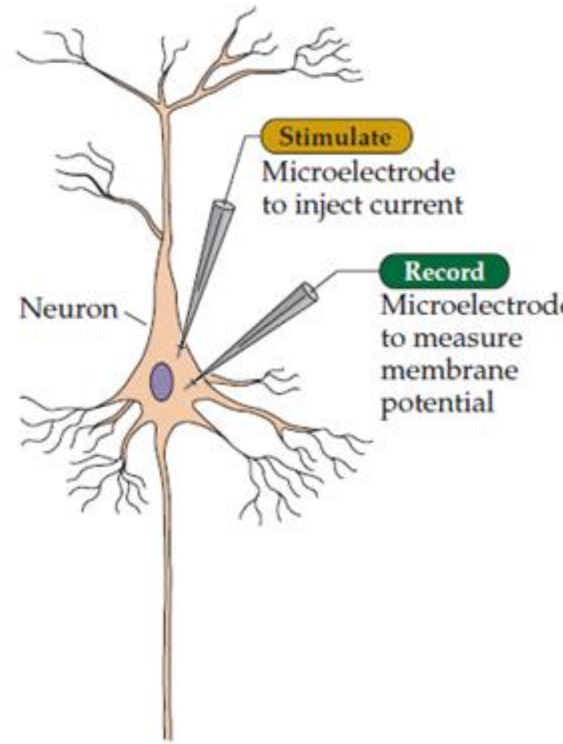
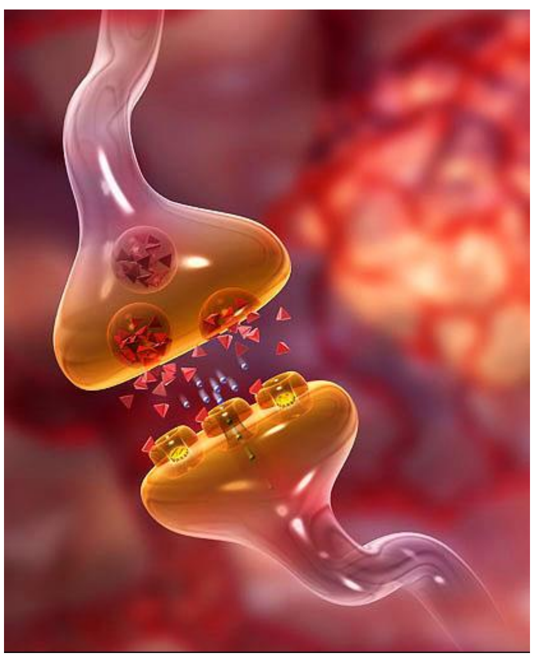
SUBTHRESHOLD ACTIVE CONDUCTANCES SHAPE THE EPSPS IN CORTICAL NEURONS

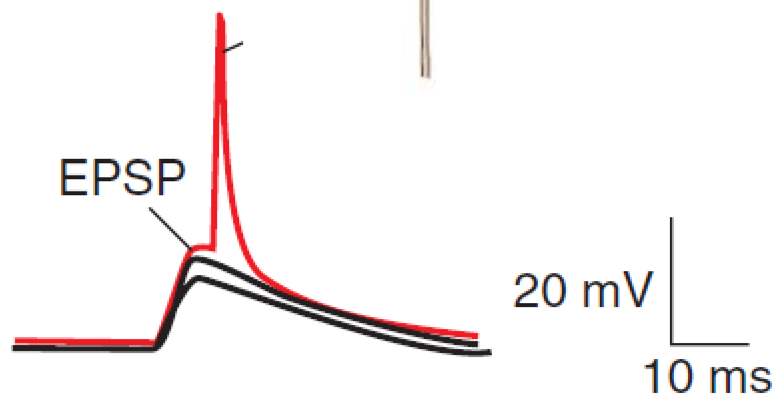
EPSPs

(B) Synaptic potential





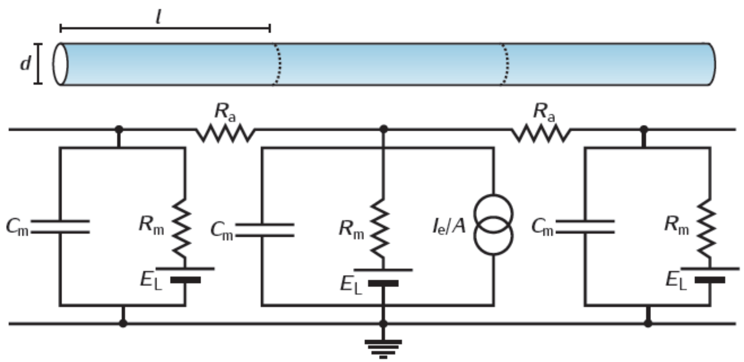




Purves et al. 2001

http://www.synsys.eu/general-public

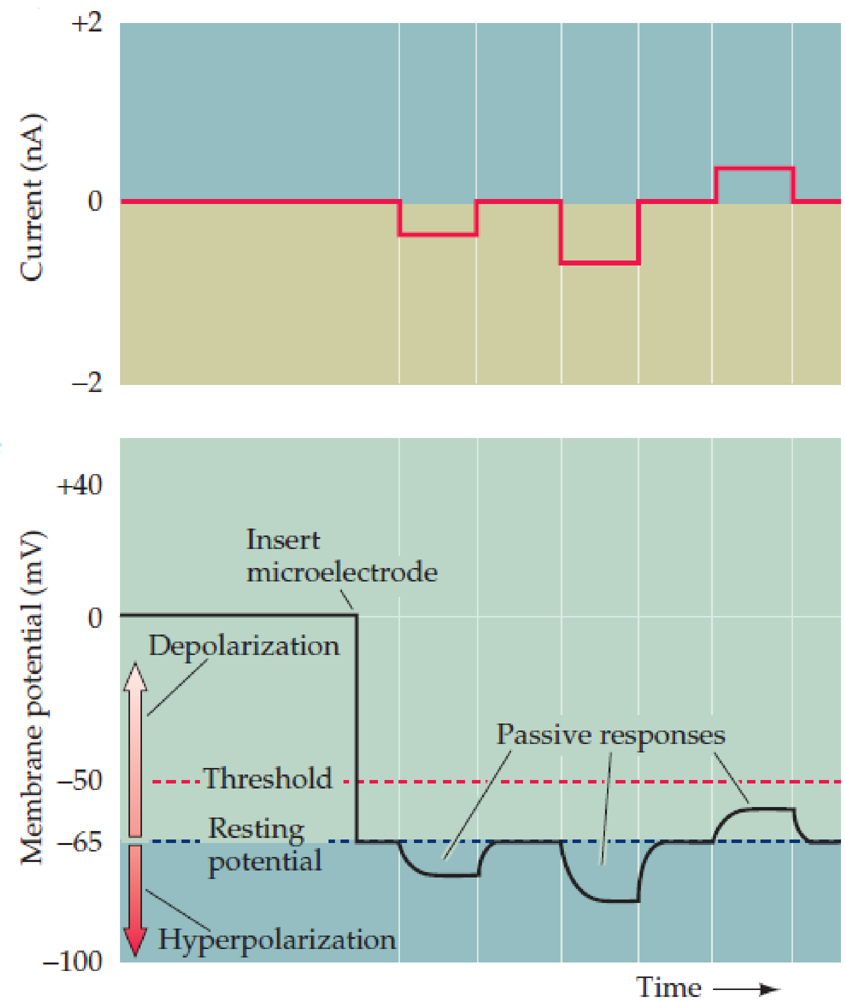
Subthreshold passive properties



$$R_{in} = \frac{dV}{dI}$$

$$V(t) = I * R_{in} * \left(1 - e^{-t/\tau}\right) + V_0$$

$$\tau = R_{in} * C$$



Sterratt et al. 2011, Purves et al. 2001

What about the subthreshold active conductances ?

$$I_{Leak} = g_{Leak} * (V - E_{rev})$$

$$I_{active} = g_{act} * A(V) * (V - E_{rev})$$

Activation variable

$$\frac{dI_{Leak}}{dV} = g_{Leak}$$

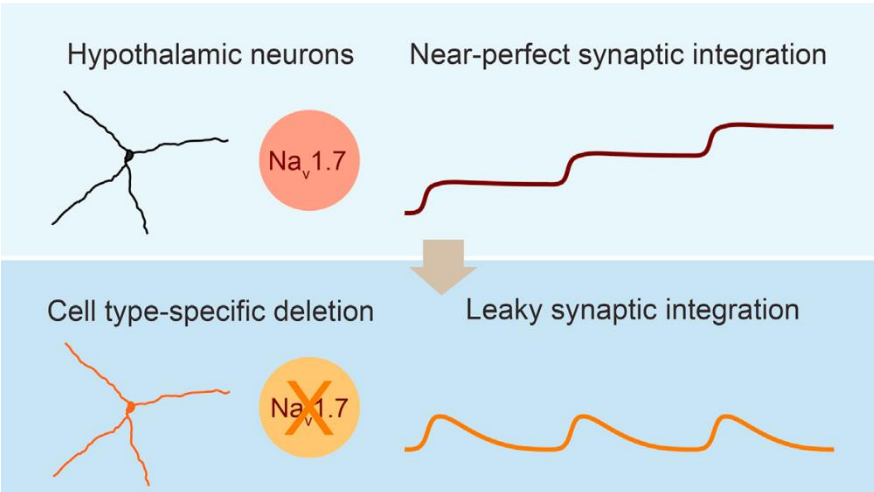
Non voltage-dependent

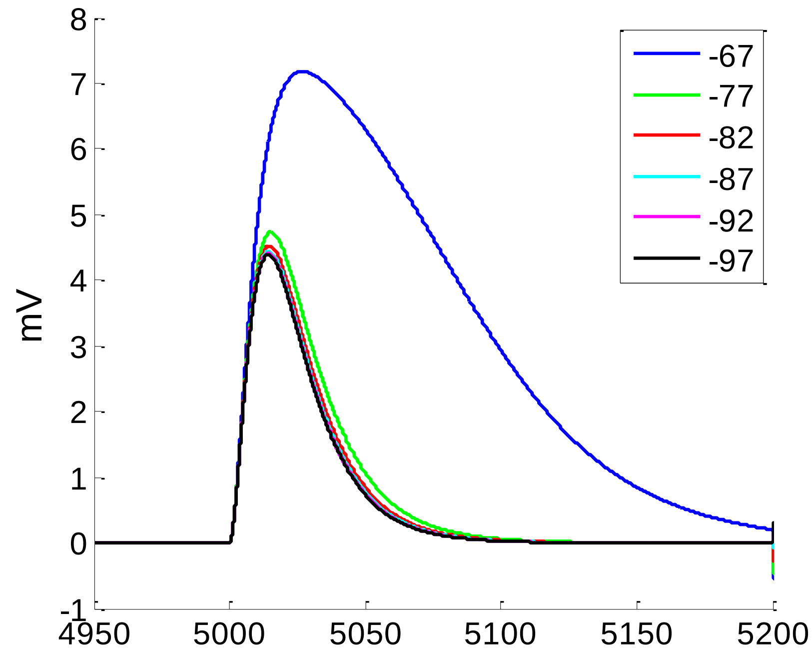
$$\frac{dI_{act}}{dV} = g_{act} * \frac{dA(V)}{dV}$$

Voltage-dependent

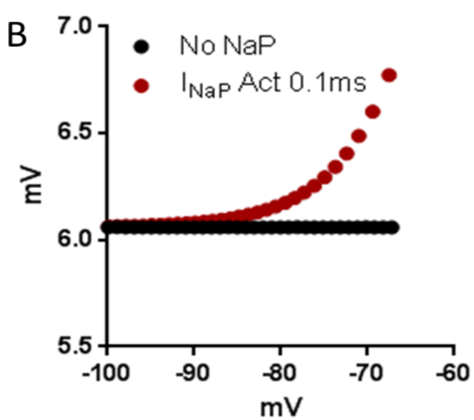
Whe need new equations that take into account the active currents ¡¡

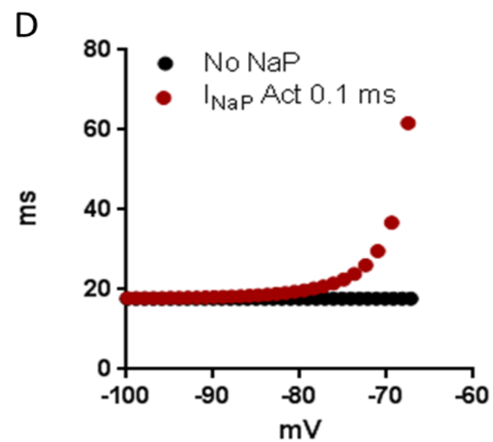
Persistent sodium current amplifies the EPSPs



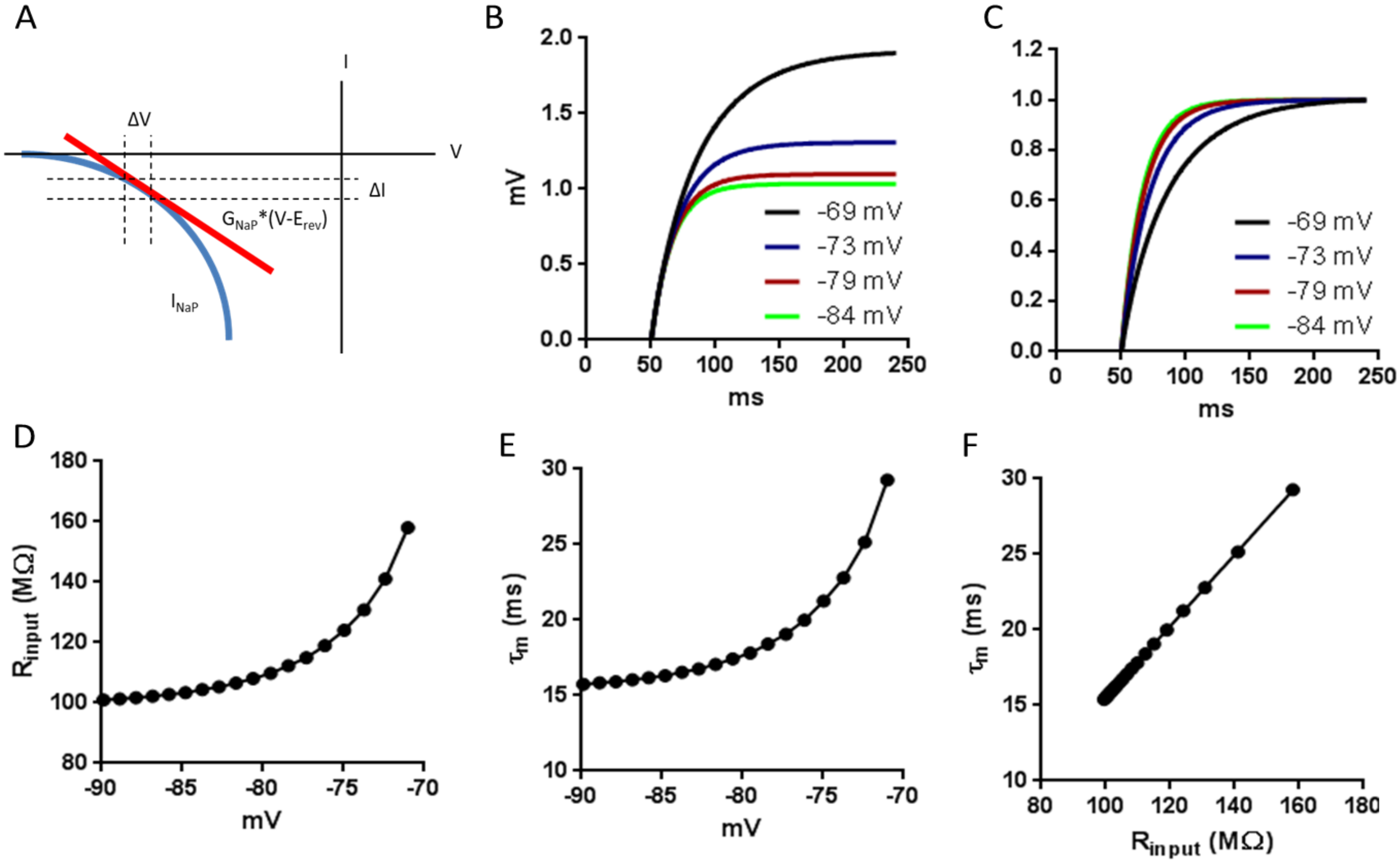


Branco et al. 2016



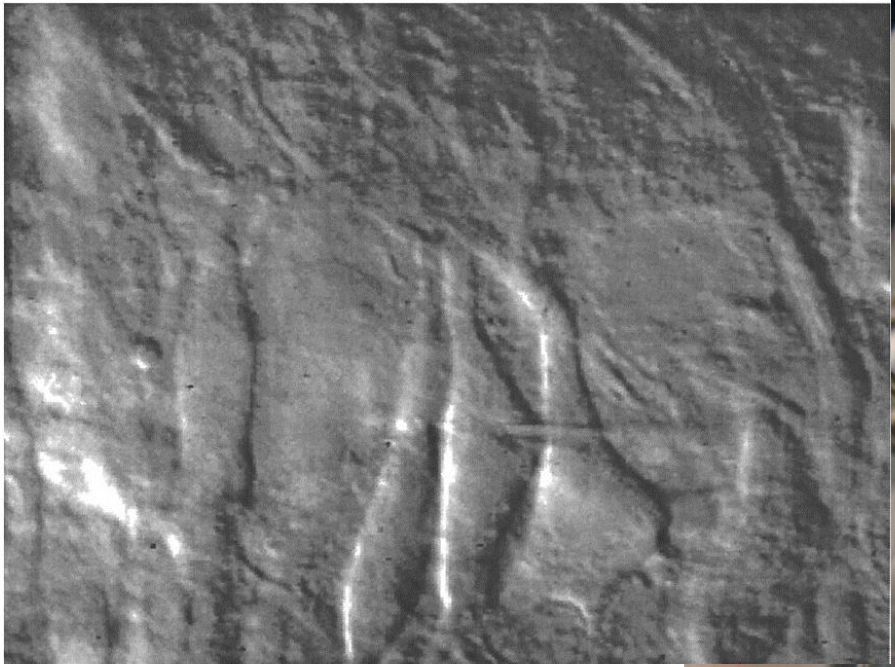


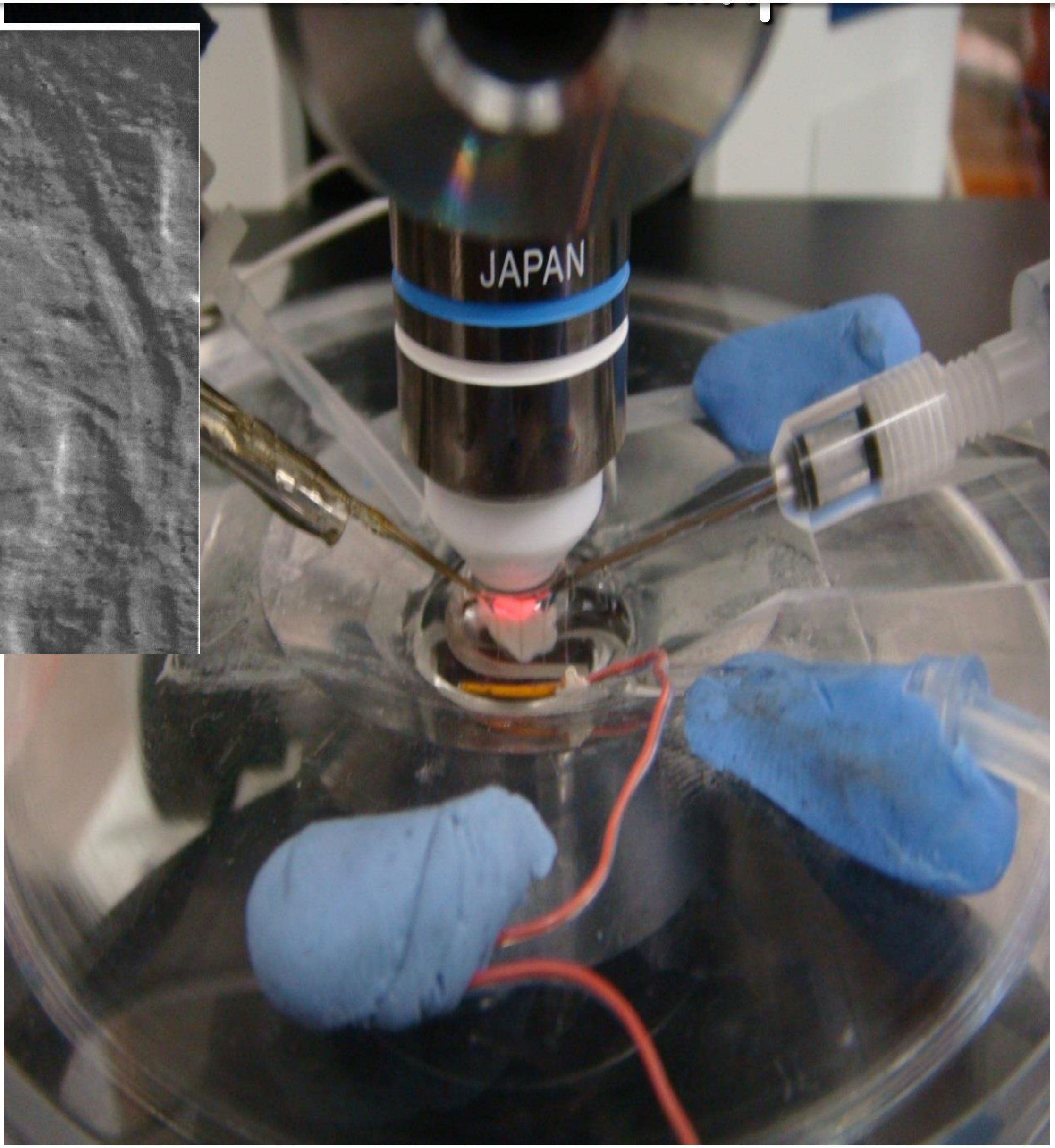
Intrinsic properties shape the EPSPs



Computational simulations of voltage dependence of R_{in} and τ_m.

Patch clamp recording

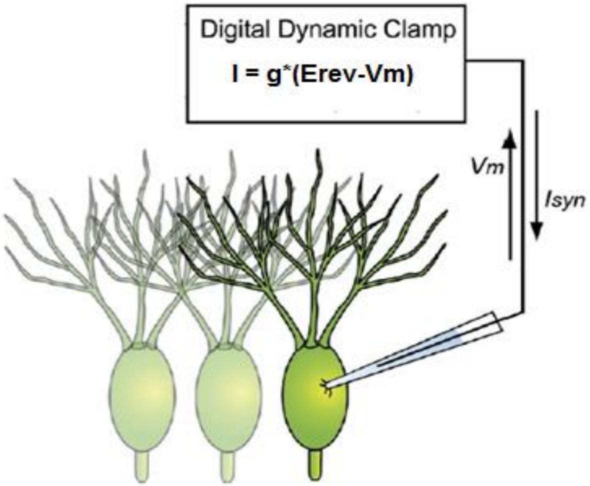


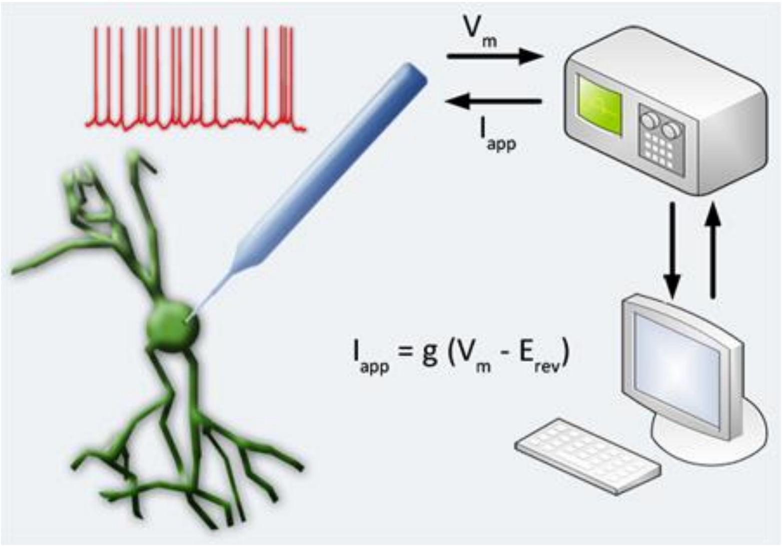


CA1 pyramidal cell
Whole cell patch clamp

Jaffe & Brown. Journal of Neurophys 1997

Dynamic clamp



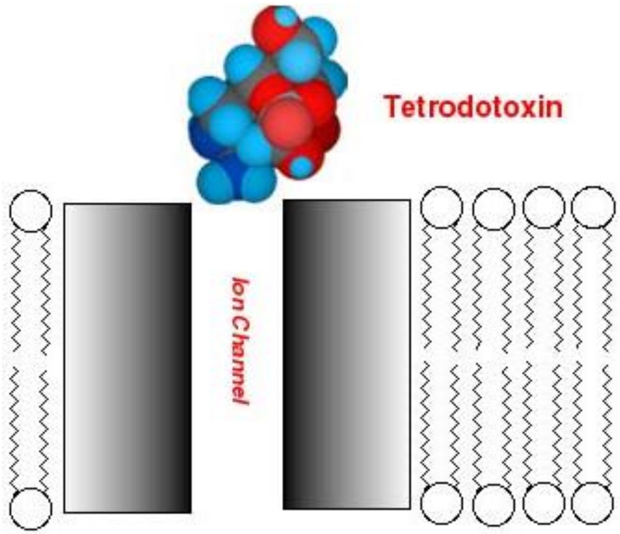


$$I = g_{nap}^{max} * A_{nap} * (V - E_{Na})$$

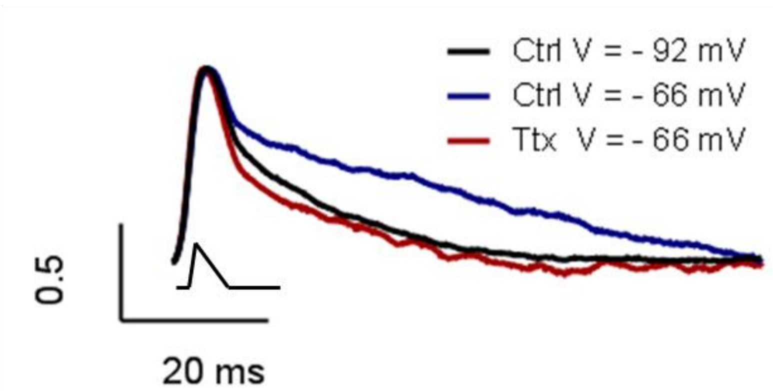
$$\frac{dA_{nap}}{dt} = \frac{A_{nap}^{\infty} - A_{nap}}{\tau}$$

$$A_{nap}^{\infty} = \frac{1}{1 + e^{(Vm+50)/-6}}$$

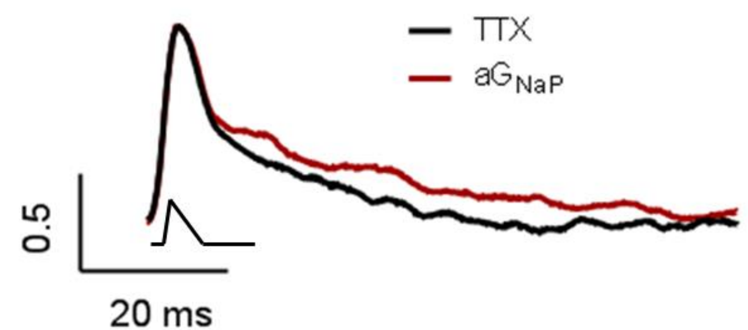
Experimental results - I_{NaP} amplifies the EPSPs



B



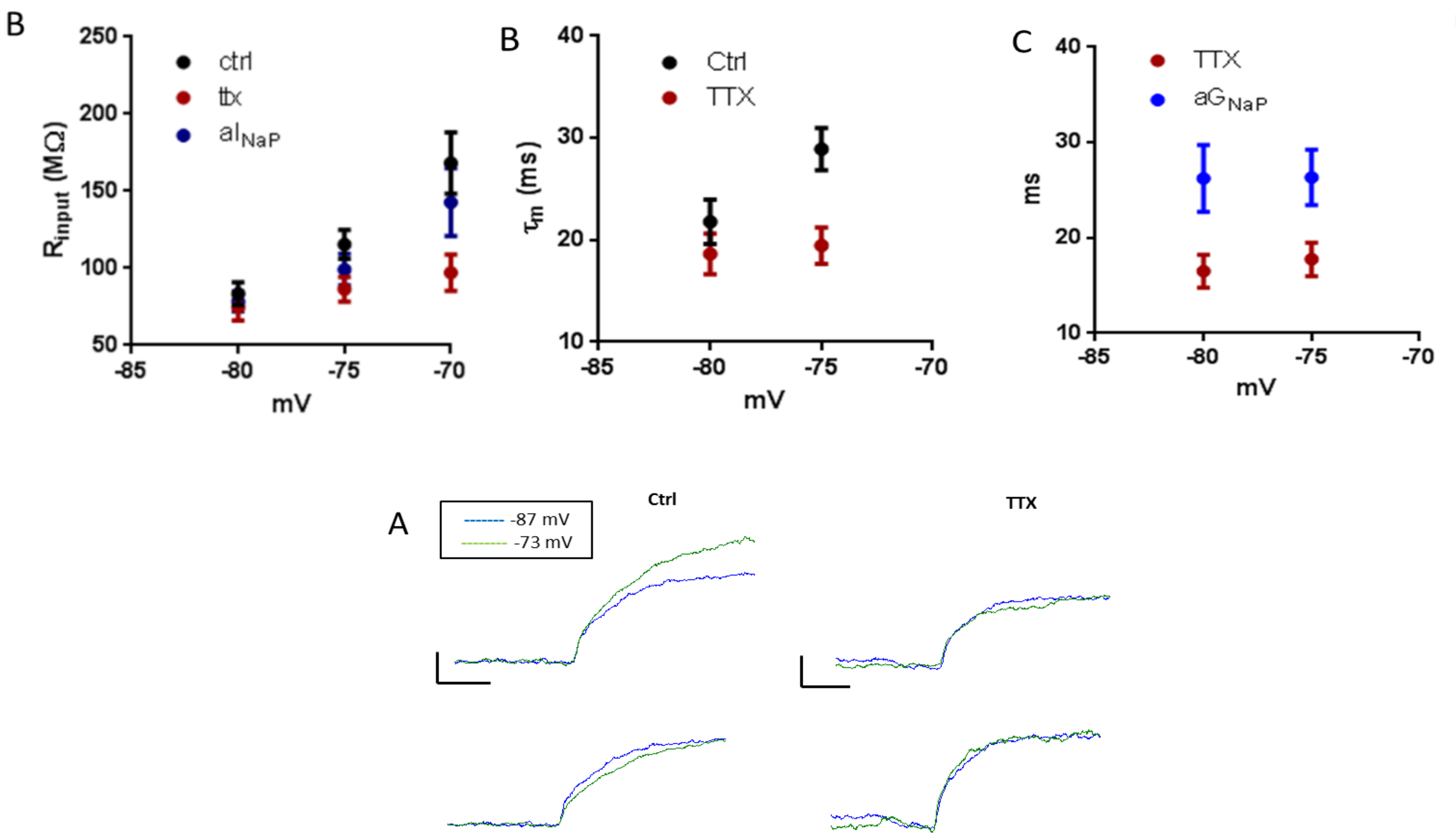
D



Puffer fish

http://www.life.umd.edu/grad/mlfsc/zctsim/ionchannel.html

R_{in} and τ are voltage dependent



The persistent sodium current increases the input resistance and membrane time constant which amplifies the EPSPs in cortical neurons

Pdf available in bioRxiv

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Confirmatory Results

THE CREATION OF A NEGATIVE SLOPE CONDUCTANCE REGION BY THE ACTIVATION OF THE PERSISTENT SODIUM CURRENT PROLONGS NEAR-THRESHOLD SYNAPTIC POTENTIALS

Cesar Ceballos, Antonio Roque, Ricardo Leao

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CAPES

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