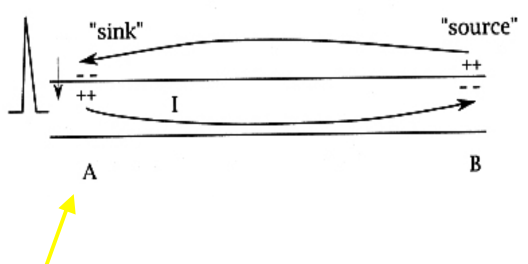
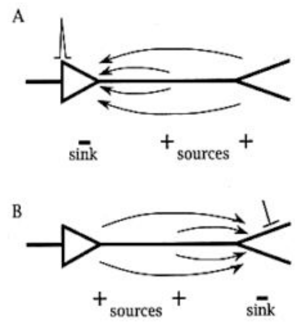
Extracellular recording

Action potential along a nerve fiber



An action potential is initiated in A

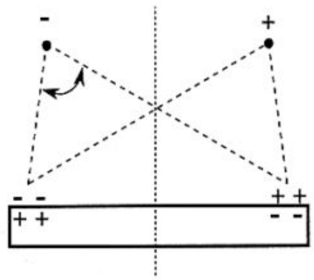
Active neuron is an electric dipole

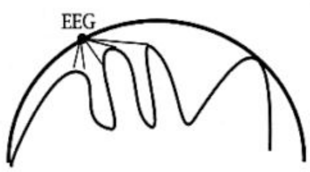


Semiquantitative theory for extracellular fields

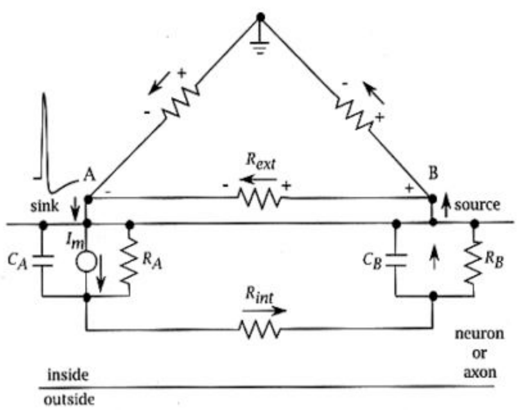
Volume conductor theory

From an observation point in a volume conductor, the measured potential will depend on the solid angle made with the dipole

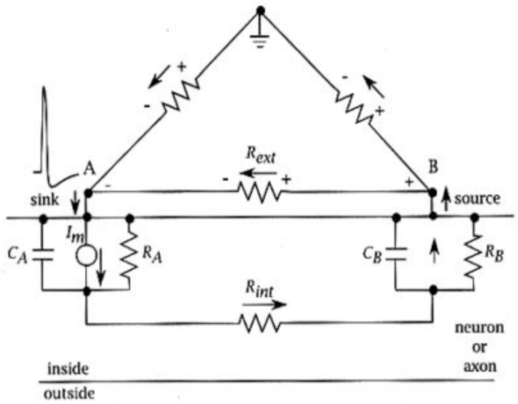




The dipole can be either one-dimensional or a dipole layer



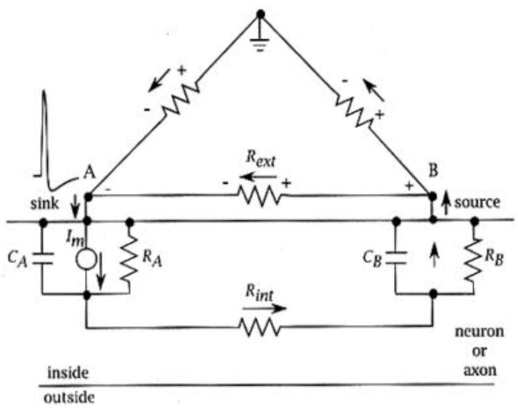
The transmembrane current I_m draws current from the extracellular space.
The time course of the inward current at A dictates the time course of the extracellular potential across R_{ext} :



For electrical events that are relatively faster than membrane time constant (action potentials and fast EPSPs), most of the current exiting at B will be capacity current across C_B ⇒ proportional di the first derivative of the transmembrane potential:

$$I_m \propto \frac{dV_m}{dt} \propto -V_B$$

This is not true for slower events, because a steady current flow would produce a steady extracellular potential



$$I_m \propto \frac{dV_m}{dt} \propto -V_B$$

The extracellular field potential has a time course that is approximately equal to the transmembrane current

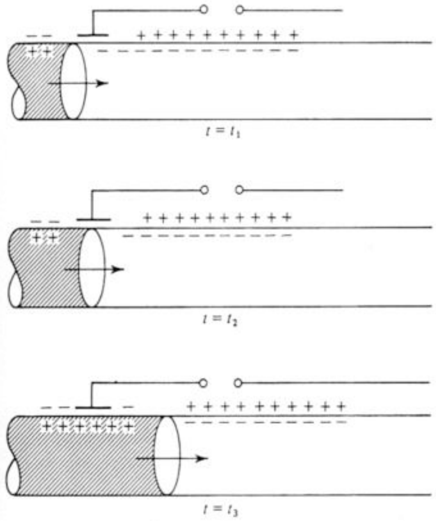


Fig. 5.9 Recording of action potential from a cylindrical axon.

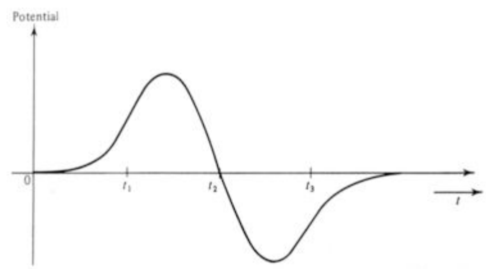
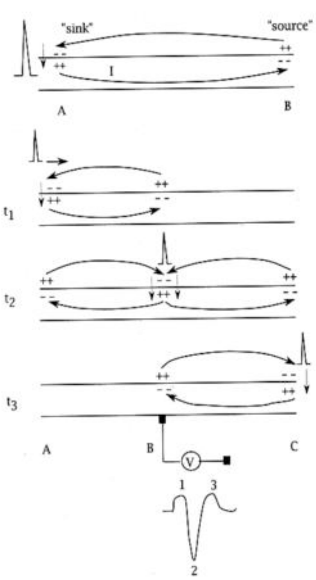


Fig. 5.10 Diphasic recorded action potential.



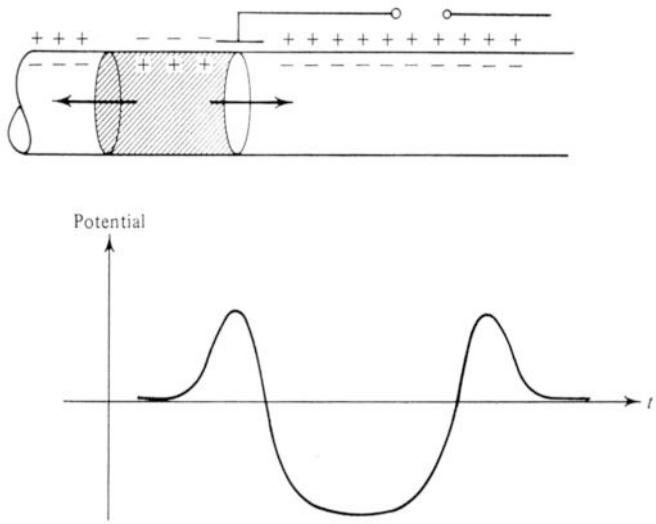


Fig. 5.11 Triphasic recorded action potential.

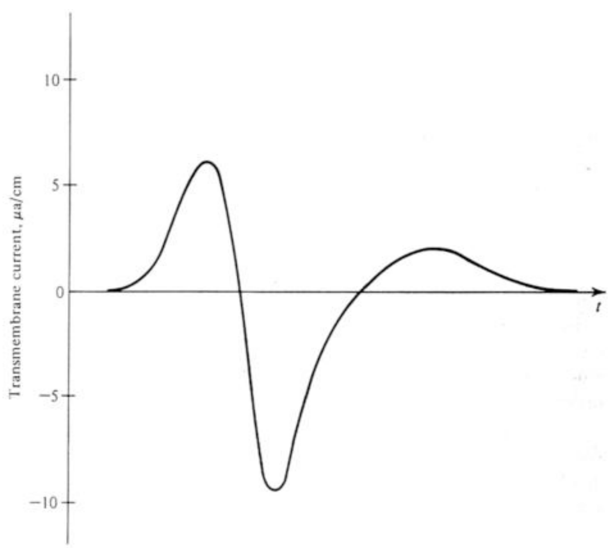


Fig. 5.16 Transmembrane current per unit length for the crayfish lateral giant axon as computed rigorously from transmembrane potential measurements. [*J. Clark and R. Plonsey, The Extracellular Potential Field of the Single Active Nerve Fiber in a Volume Conductor, Biophys. J.*, **8**:842 (1968).]

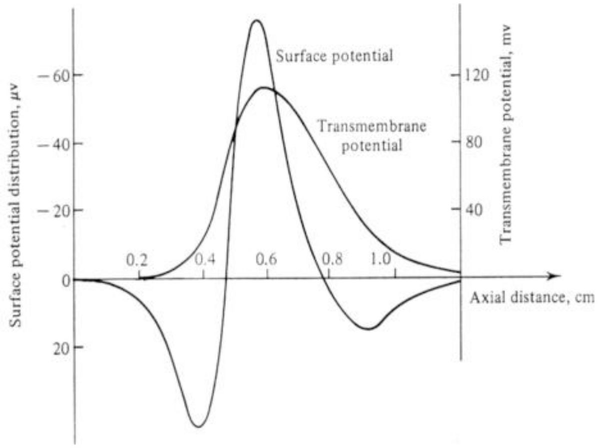


Fig. 5.22 Transmembrane-potential variation from direct measurement and surface-potential distribution computed therefrom, for the crayfish lateral giant axon. (*J. Clark, "Bioelectric Field Interaction between Adjacent Nerve Fibers," Ph.D. thesis, Case Western Reserve University, November,* 1967.)

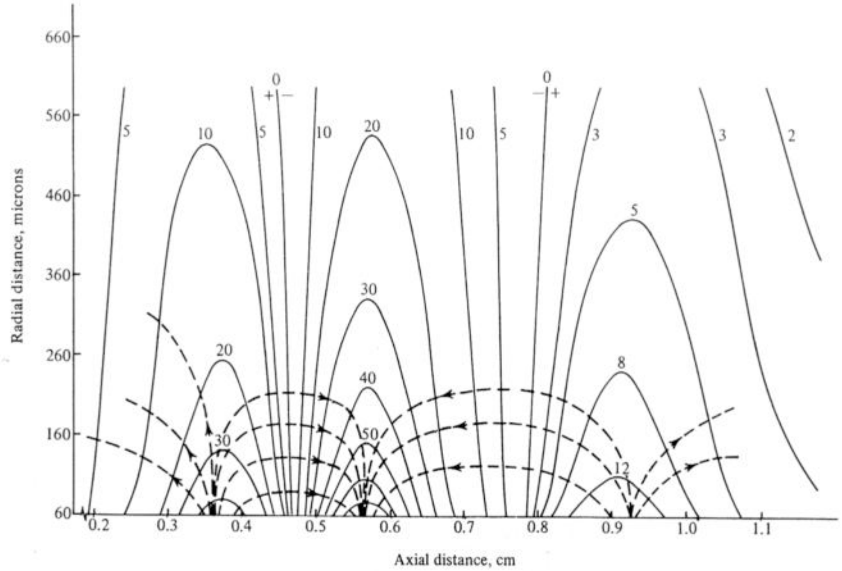
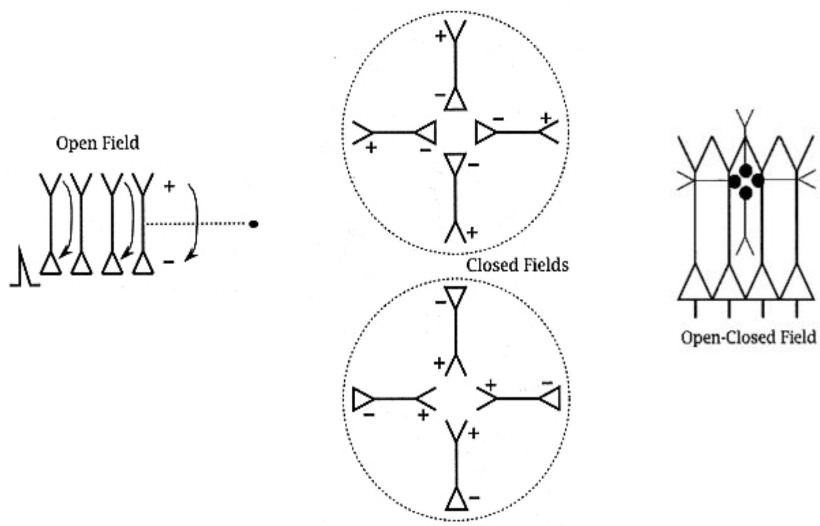
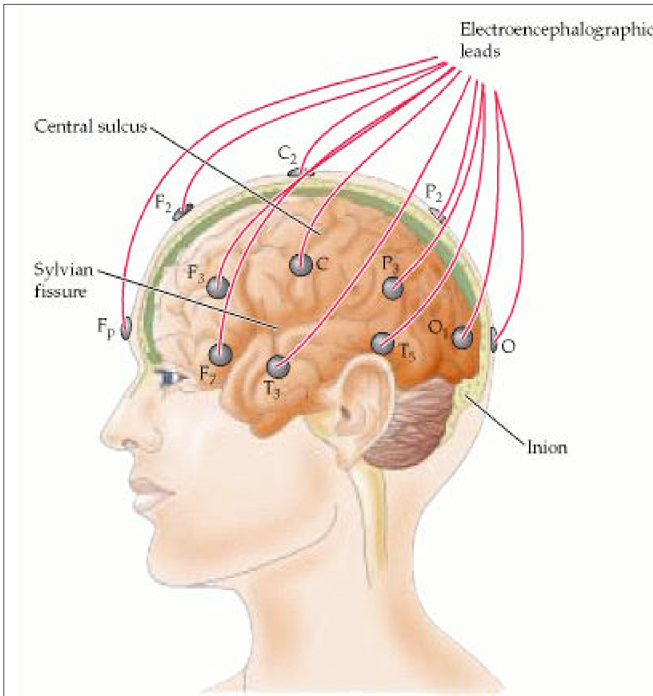


Fig. 5.23 Calculated field distribution of a crayfish lateral giant axon in a uniform conducting medium of infinite extent based on measured transmembrane potential. The axon radius is 60 microns. Isopotential lines are solid, current flow lines are dashed; potentials are in microvolts. (*After J. Clark, "Bioelectric Field Interaction between Adjacent Nerve Fibers," Ph.D. thesis, Case Western Reserve University, November,* 1967.)

Classification of fields





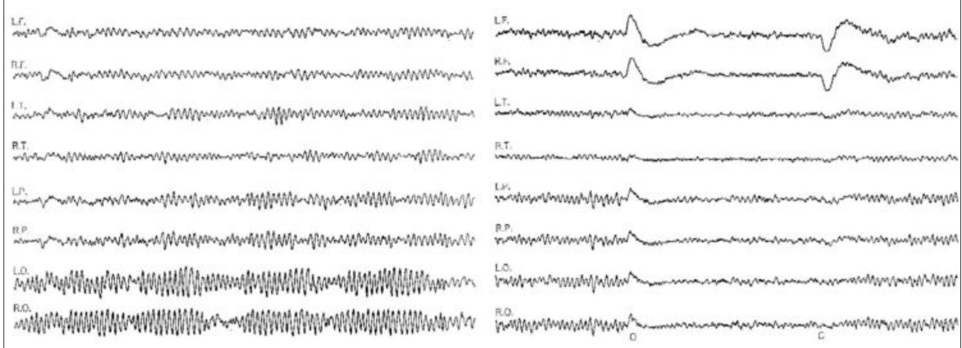
Derivazioni standard per la registrazione dell’EEG dal cuoio capelluto

Box C

Da: Purves “Neuroscience”

Elettroencefalogramma in un soggetto umano normale

EEG durante la veglia rilassata | Reazione di arresto di Berger



Occhi aperti

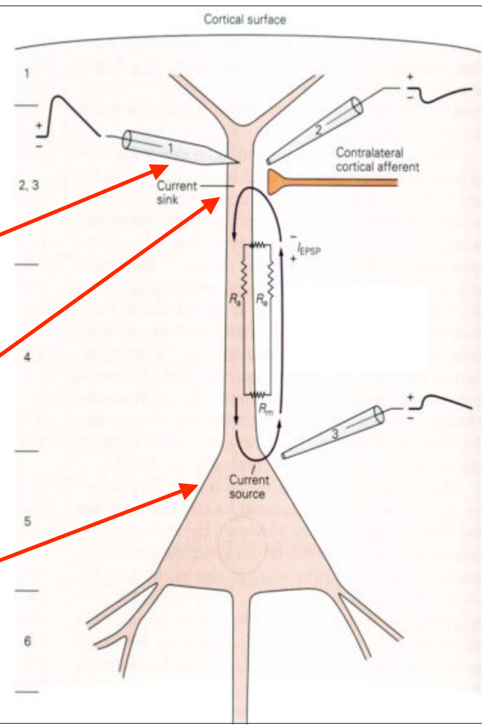
Da: Moruzzi "Fisiologia della vita di relazione"

Correnti elettriche durante un PPSE nel dendrite apicale di un neurone piramidale di neocorteccia

Elettrodo 1: registrazione intracellulare

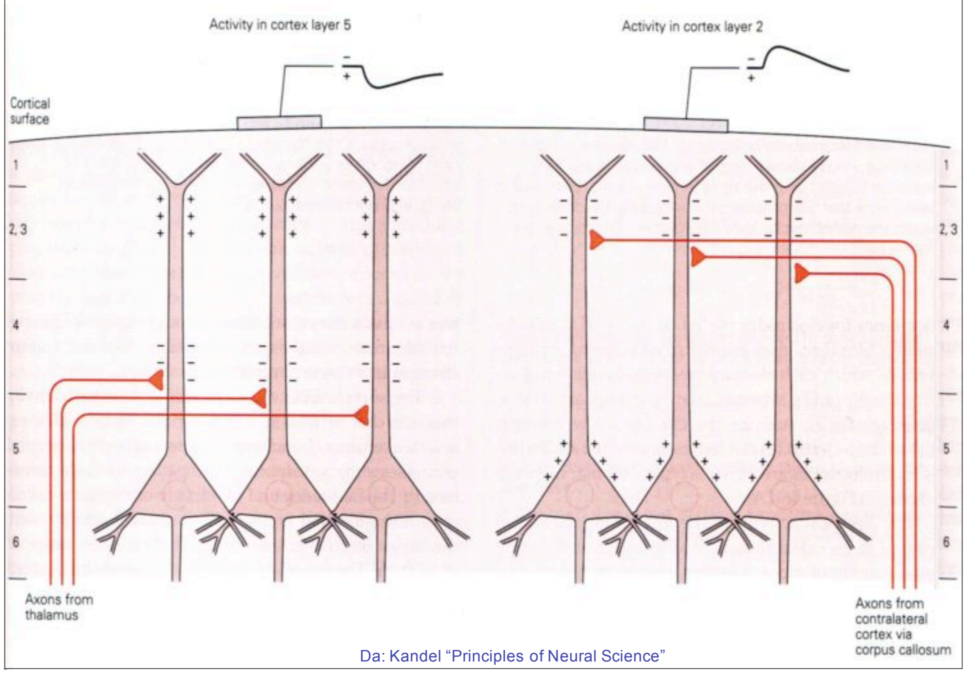
Elettrodo 2: registrazione extracellulare nel sito del PPSE

Elettrodo 3: registrazione extracellulare presso il soma

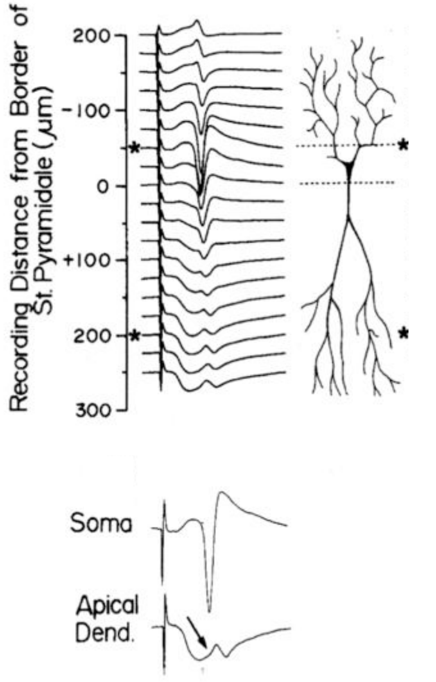


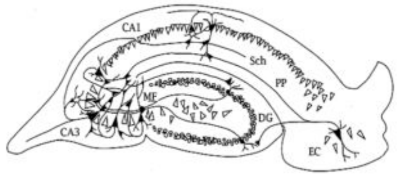
Da: Kandel "Principles of Neural Science"

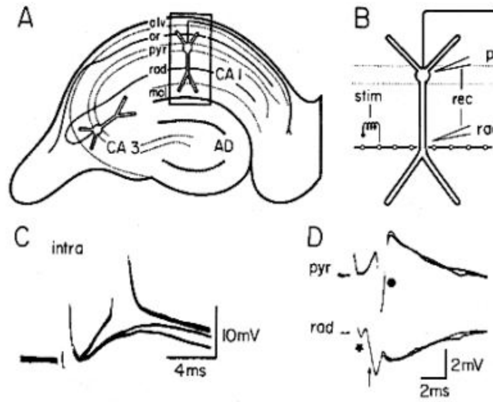
La polarità superficiale dipende dal sito dell’attività sinaptica

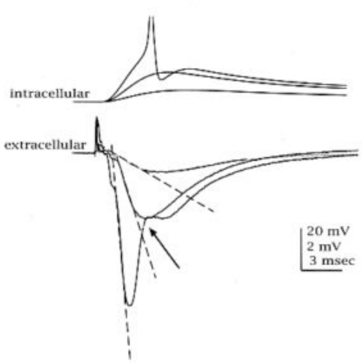


Da: Kandel “Principles of Neural Science”

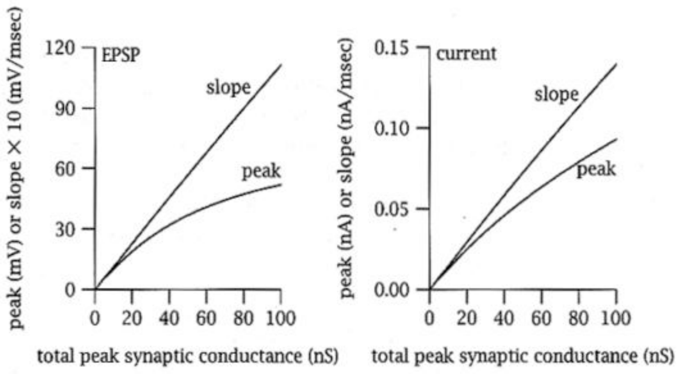



CA1
Sch
PP
ME
DG
CA3
EC

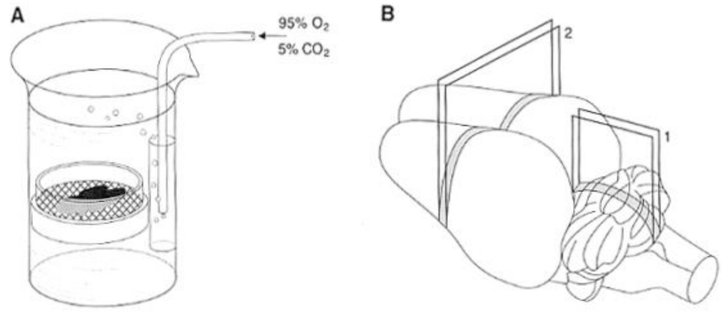

A
alv
or
pyr
rad
mol
CA1
CA 3
AD
B
pyr
stim
rec
rad
C
intra
10mV
4ms
D
pyr
rad
2mV
2ms

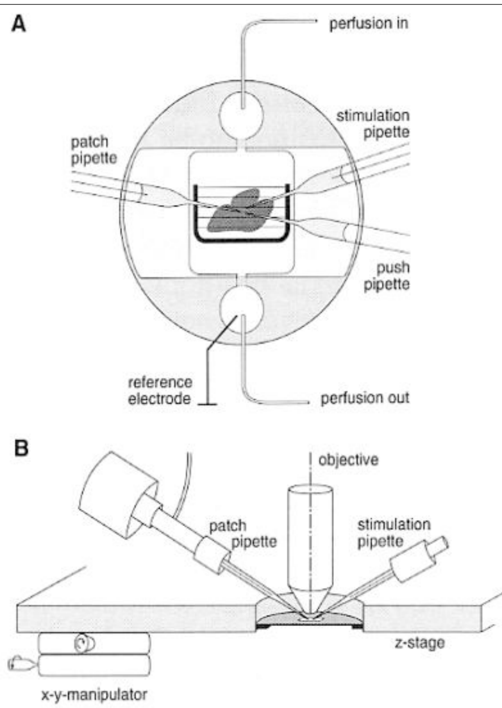

intracellular
extracellular
20 mV
2 mV
3 msec

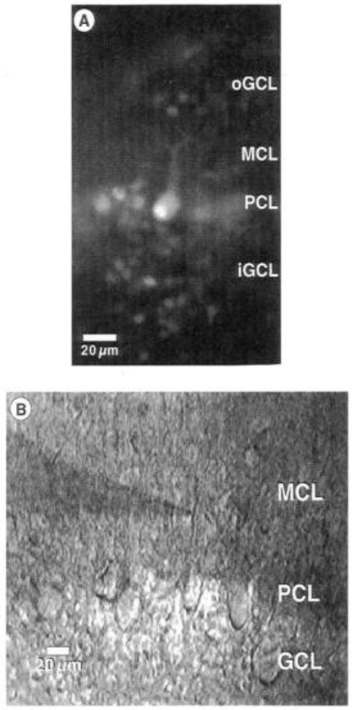
EPSP EPSC

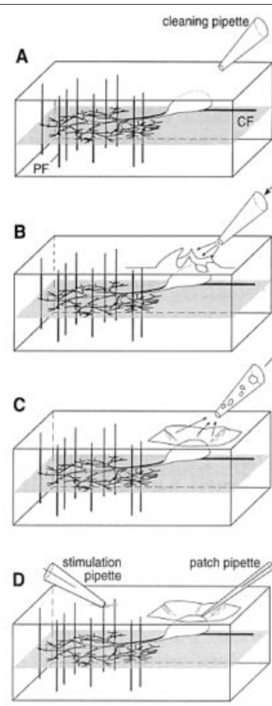


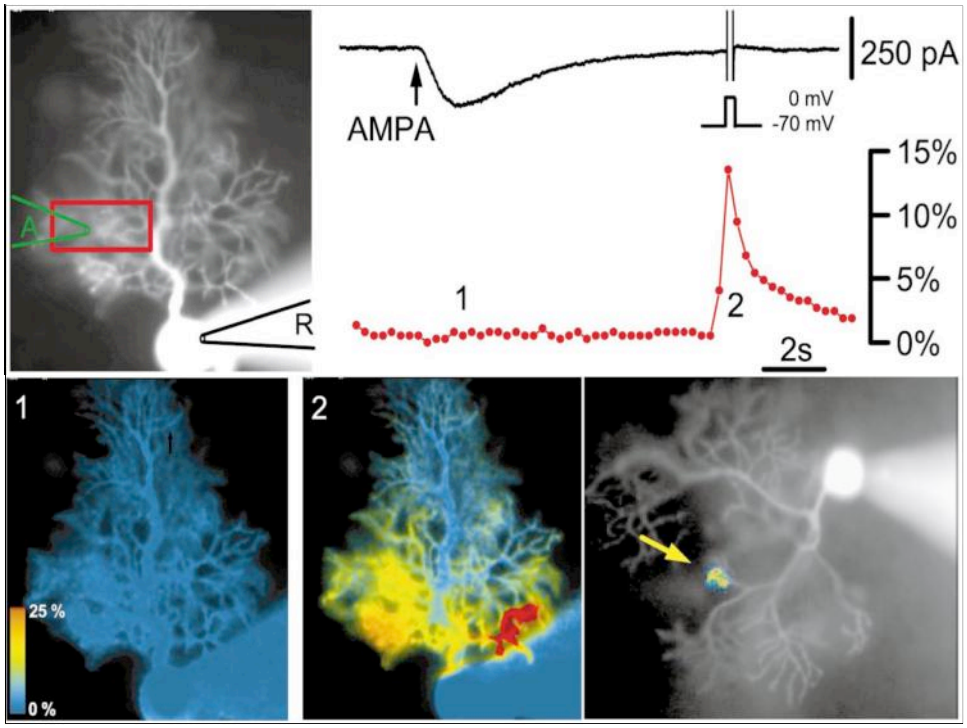
Patch-clamp
in tissue slices


A
95% O_2
5% CO_2
B
2
1

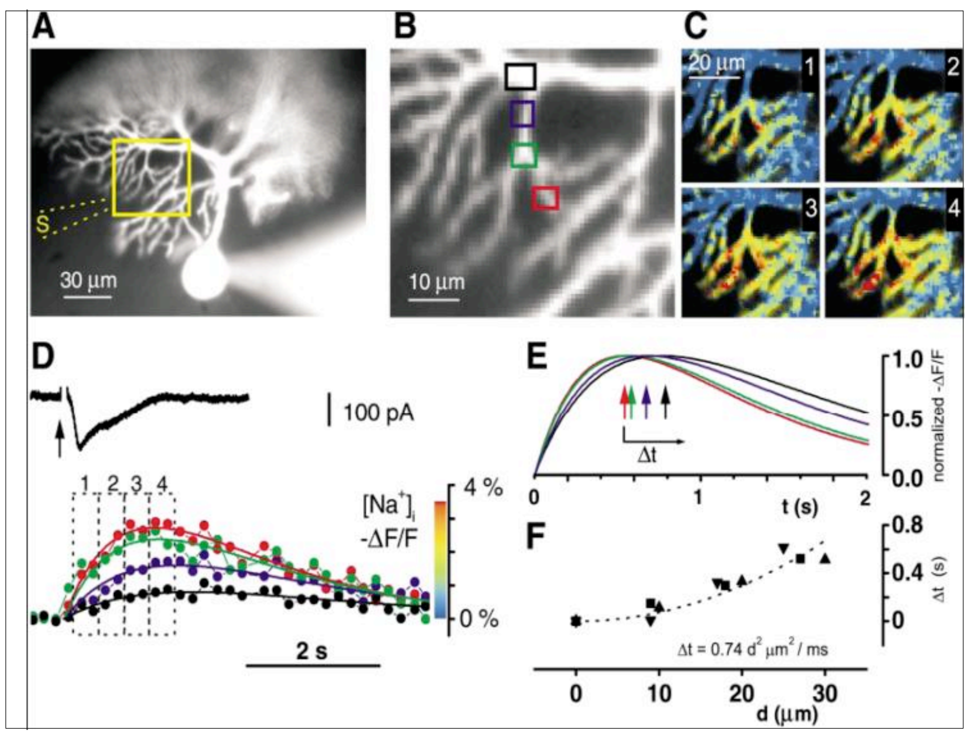

A
perfusion in
stimulation pipette
patch pipette
push pipette
reference electrode
perfusion out
B
objective
patch pipette
stimulation pipette
z-stage
x-y-manipulator


A
oGCL
MCL
PCL
iGCL
20 μm
B
MCL
PCL
GCL
20 μm

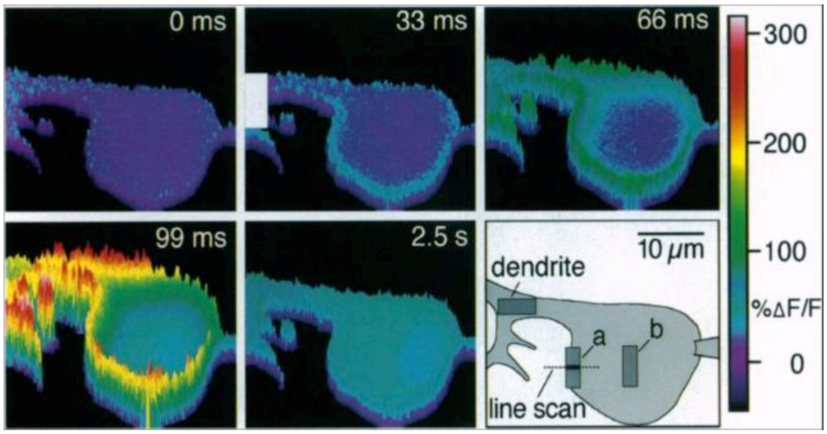

cleaning pipette
A
CF
PF
B
C
stimulation pipette
patch pipette
D



250 pA
AMPA
0 mV
-70 mV
15%
10%
5%
0%
1
2
2s
A
R
25 %
0 %



A
B
C
S
30 µm
10 µm
20 µm
D
100 pA
[Na+]i
-ΔF/F
4 %
0 %
2 s
E
normalized -ΔF/F
Δt
t (s)
F
Δt (s)
Δt = 0.74 d² µm² / ms
d (µm)


0 ms
33 ms
66 ms
99 ms
2.5 s
10 μm
dendrite
a
b
line scan
300
200
100
%ΔF/F
0