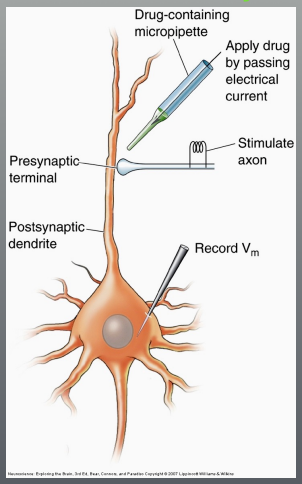
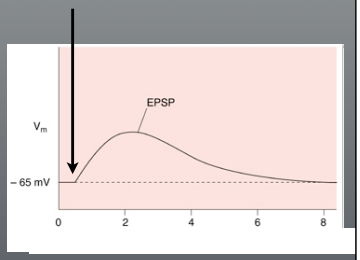
Stimulating Neurons

- electrical stimulation with an electrode to bring neuron above AP threshold
- depolarize neuron by changing extracellular K+ concentration
- apply neurotransmitters/drugs that cause ligand-gated channels to open (eg glutamate)
- transcranial magnetic stimulation to induce current in neurons (noninvasive because magnetic field penetrates skull, body)
- optogenetics: insert transgenes for channels that are light-gated

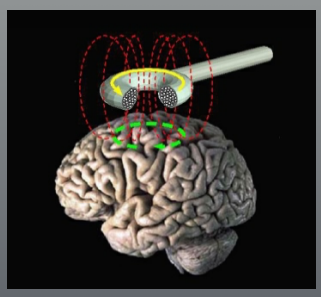
Stimulate electrically or with drug/neurotransmitter

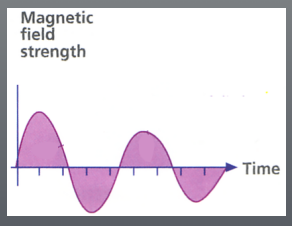


apply drug (e.g. Glutamate) that opens Na+ channels

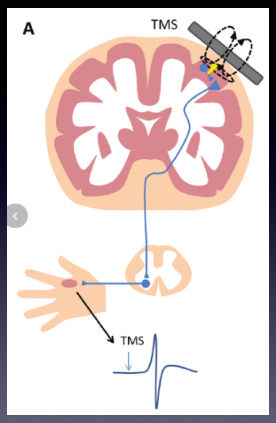


Transcranial Magnetic Stimulation
magnetic field -> electric current -> depolarization



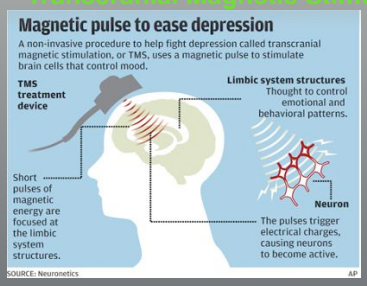


Transcranial magnetic stimulation (TMS) over motor cortex and TMS paradigms assessing various inhibitory and excitatory neuronal populations. (A) TMS generates a fast, time-varying magnetic field, which penetrates the skull, inducing an electric field in underlying tissue, and depolarizes cortical neurons. At high enough intensities, stimulation of motor cortical regions results in motor-evoked potentials (MEPs) in peripheral muscles controlled by these areas, which can be measured using electromyography

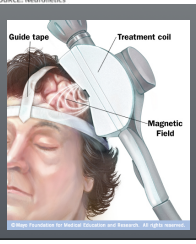


https://www.researchgate.net/figure/Transcranial-magnetic-stimulation-TMS-over-motor-cortex-and-TMS-paradigms-assessing_fig1_236976

Transcranial Magnetic Stimulation



Neuronetics NeuroStar system



40 min Rx x 5/week x 6 weeks

Optogenetics

Channelrhodopsins

Rhodopsins from microalgae and eubacteria that mediate phototaxis for photosynthesis
light -> increased Na+ influx
light -> incresed Cl- influx

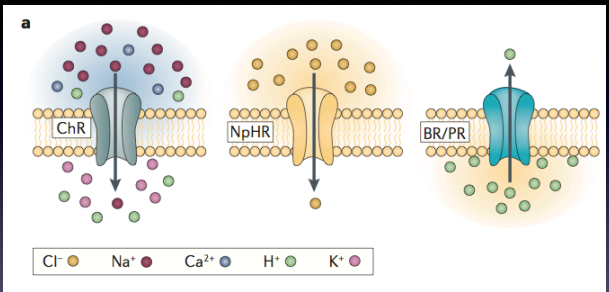
Photoactivated Cyclases

light -> increased cAMP

LITE

light -> increased transcription

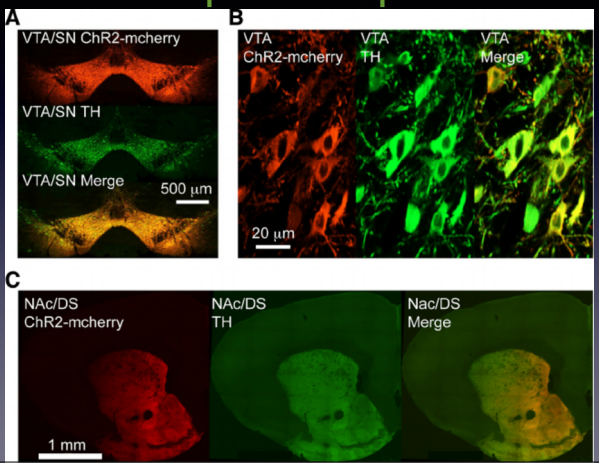
Channelrhodopsins



Major classes of single-component optogenetic tools include cation-permeable channels for membrane depolarization (such as channelrhodopsins (ChRs)), chloride pumps (for example, halorhodopsin (NpHR)) and proton pumps (such as bacteriorhodopsin or proteorhodopsin (BR/PR)) for membrane hyperpolarization.

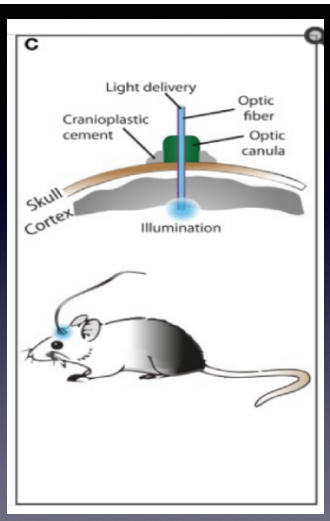
Tye Nature Reviews Neuroscience 13 (2012) 251

Transgenic Mice with channelrhodopsins in dopamine cells



Fiber optics

to activate channelrhodopsins in vivo



Videos

https://www.youtube.com/watch?v=Kj2MqEMpj4U hypothalamic electrical stimulation of cats

https://www.youtube.com/watch?v=I64X7vHSHOE method of the year

https://www.youtube.com/watch?v=88TVQZUfYGw locomotion

https://www.youtube.com/watch?v=FlGbznBmx8M predatory swtich

https://www.youtube.com/watch?v=_z51OGBaWko drinking switch