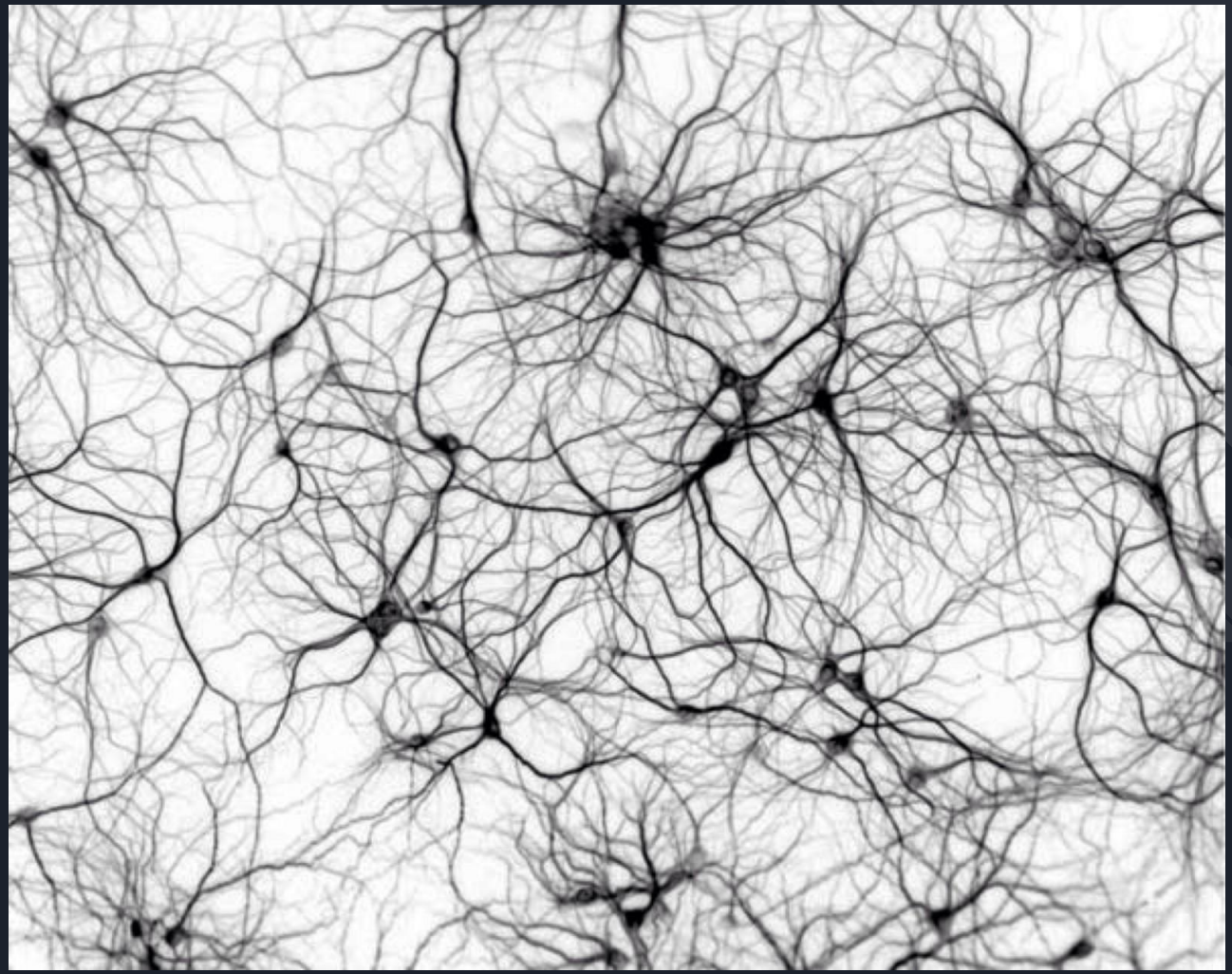
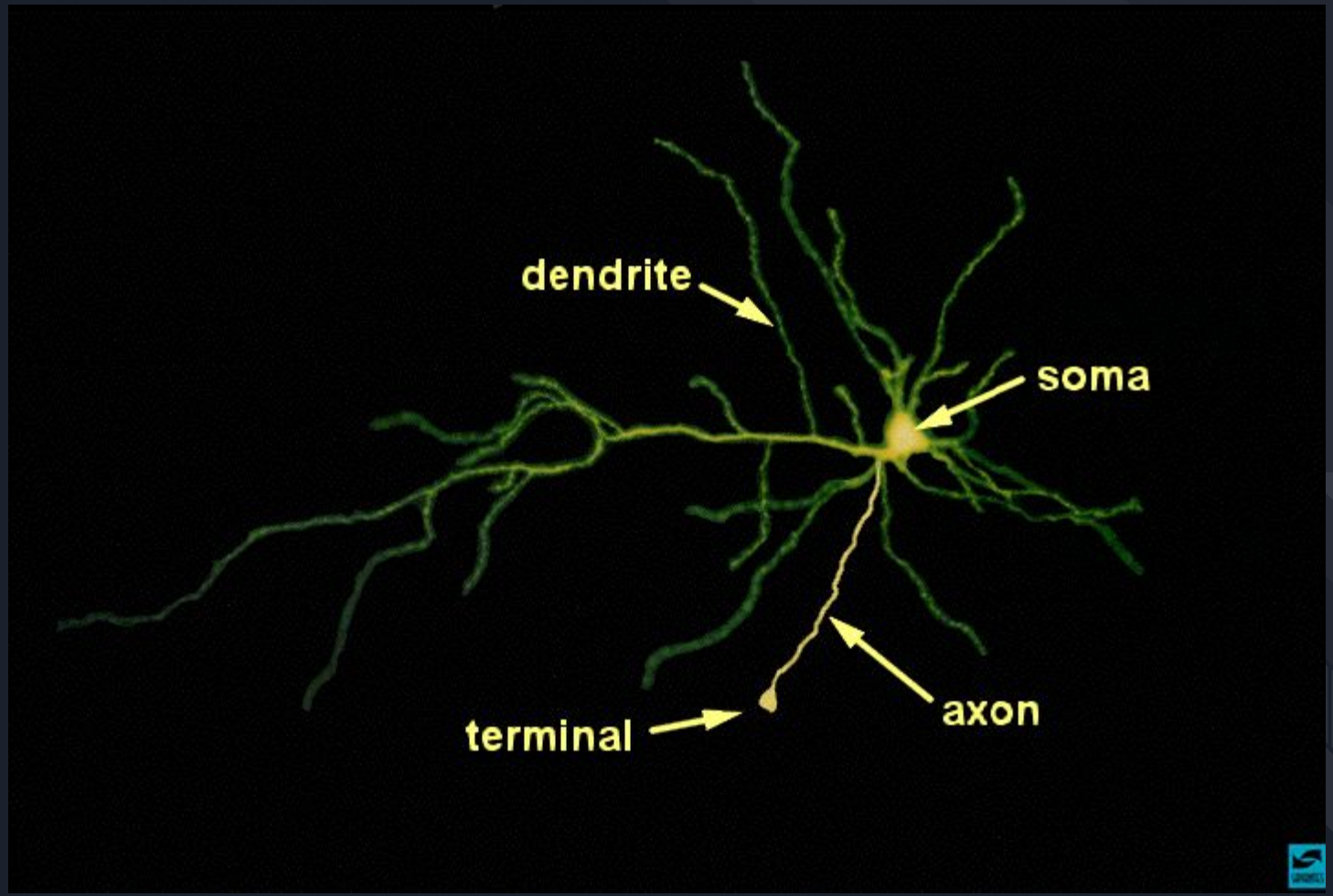
Lecture 1-- **Spikes**

Maria Kesa

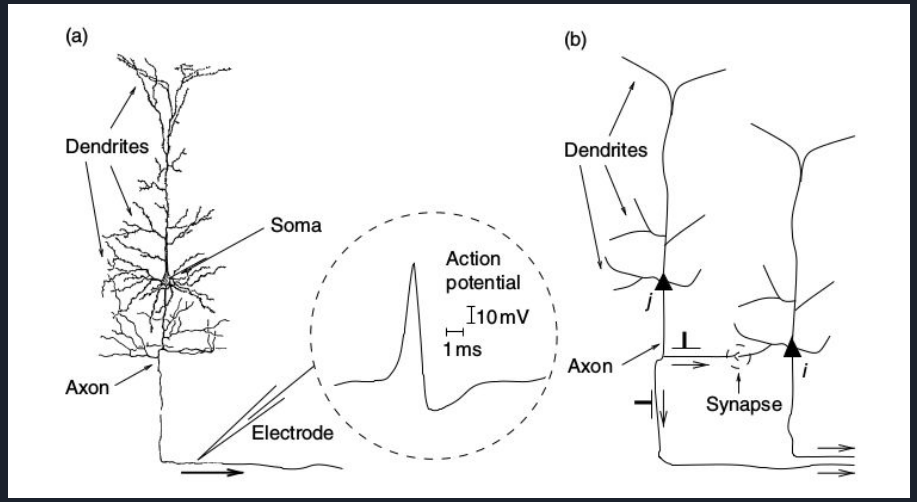


The Brain is Mysterious.


dendrite
soma
terminal
axon

How do neurons communicate?

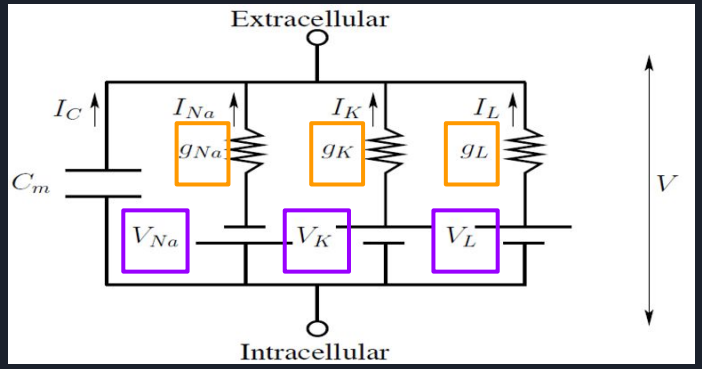
With Spikes and Neurotransmitters



From “Neuronal Dynamics”, Gerstner et al, https://neuronaldynamics.epfl.ch/

Hodgkin-Huxley Model

Nobel Prize in Physiology or Medicine, 1963



$$I = C_m \frac{\mathrm{d}V_m}{\mathrm{d}t} + \bar{g}_{\mathrm{K}} n^4 (V_m - V_K) + \bar{g}_{\mathrm{Na}} m^3 h (V_m - V_{Na}) + \bar{g}_l (V_m - V_l),$$

$$\frac{dn}{dt} = \alpha_n(V_m)(1-n) - \beta_n(V_m)n$$

$$\frac{dm}{dt} = \alpha_m(V_m)(1-m) - \beta_m(V_m)m$$

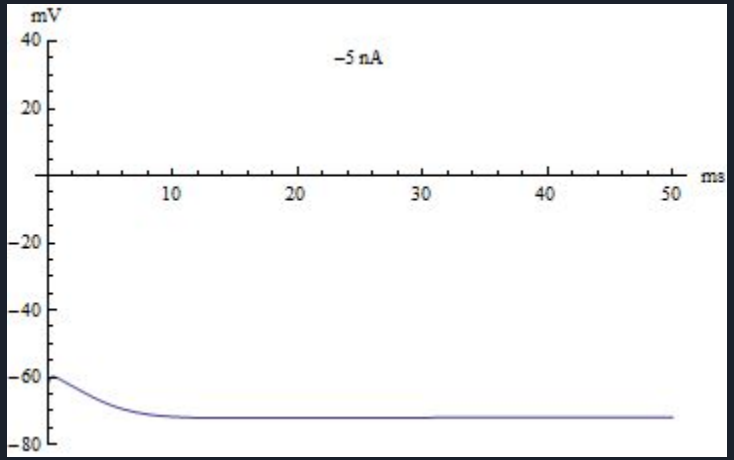
$$\frac{dh}{dt} = \alpha_h(V_m)(1-h) - \beta_h(V_m)h$$

Conductances

Gating variables

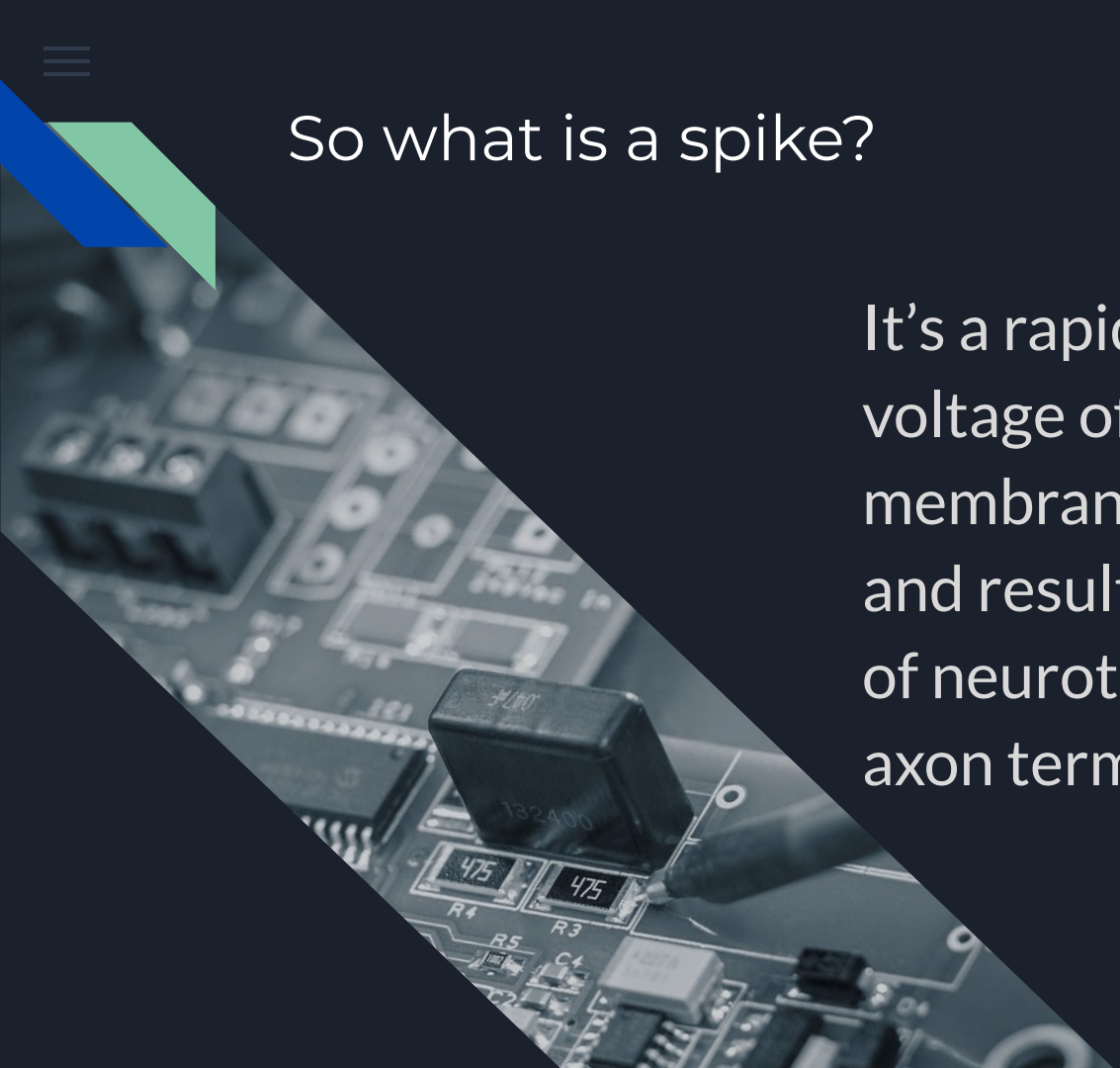
Reversal potentials

Solution of the equation for currents that are Inserted into the neuron (mimicking real synaptic input)



https://en.wikipedia.org/wiki/Hodgkin%E2%80%93Huxley_model#/media/File:Hodgkins_Huxley_Plot.gif

So what is a spike?



It’s a rapid fluctuation in the voltage of the neuronal membrane that propagates and results in synaptic release of neurotransmitter at the axon terminal.

Let’s simulate some SPIKES!