



Workshop Series Summer 2023

C A M B A M

Centre for Applied Mathematics
in Bioscience and Medicine

June 16th, 2023

Exploring Single Neuron Excitability with Mathematical and Computational Models

By Niklas Brake and Nils Koch

Workshop Schedule

9:00 – 12:00

Morning session

- *Introduction to Neurobiological Context*
- *Experimental Quantification of Neuronal Excitability*
- *Computer Lab #1*
- *Theory of Neuronal Excitability*

12:00 – 13:30

Lunch Break

13:30 – 17:00

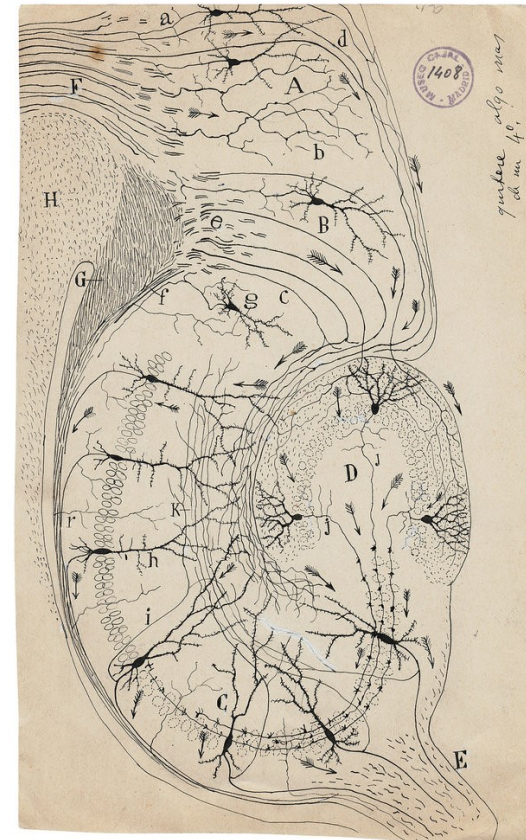
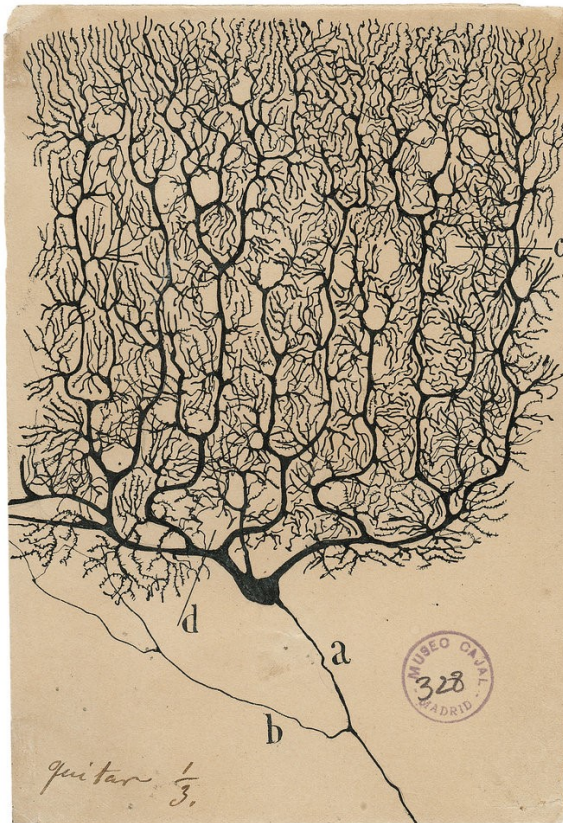
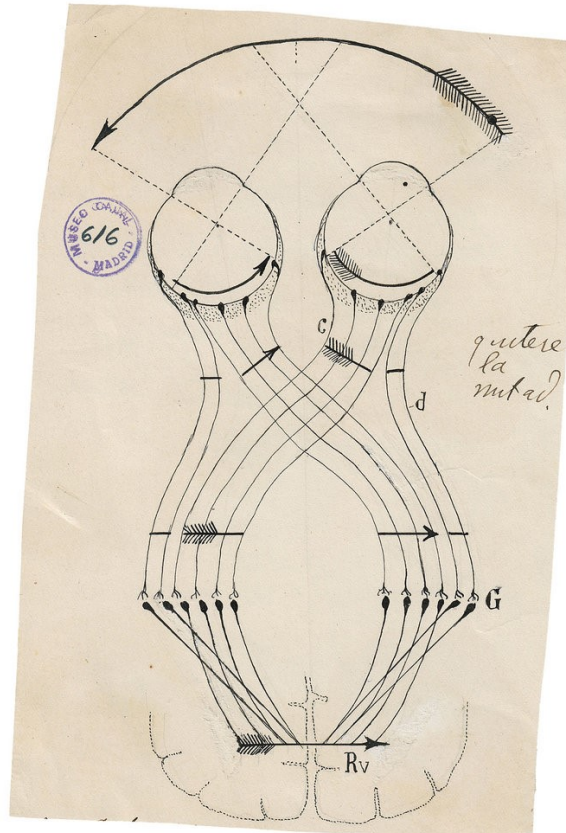
Afternoon session

- *Numerical Methods for Simulating Neurons*
- *Computer Lab #2*
- *The Process of Model Optimization*
- *Computer Lab #3*



Introduction to Neurobiological Context

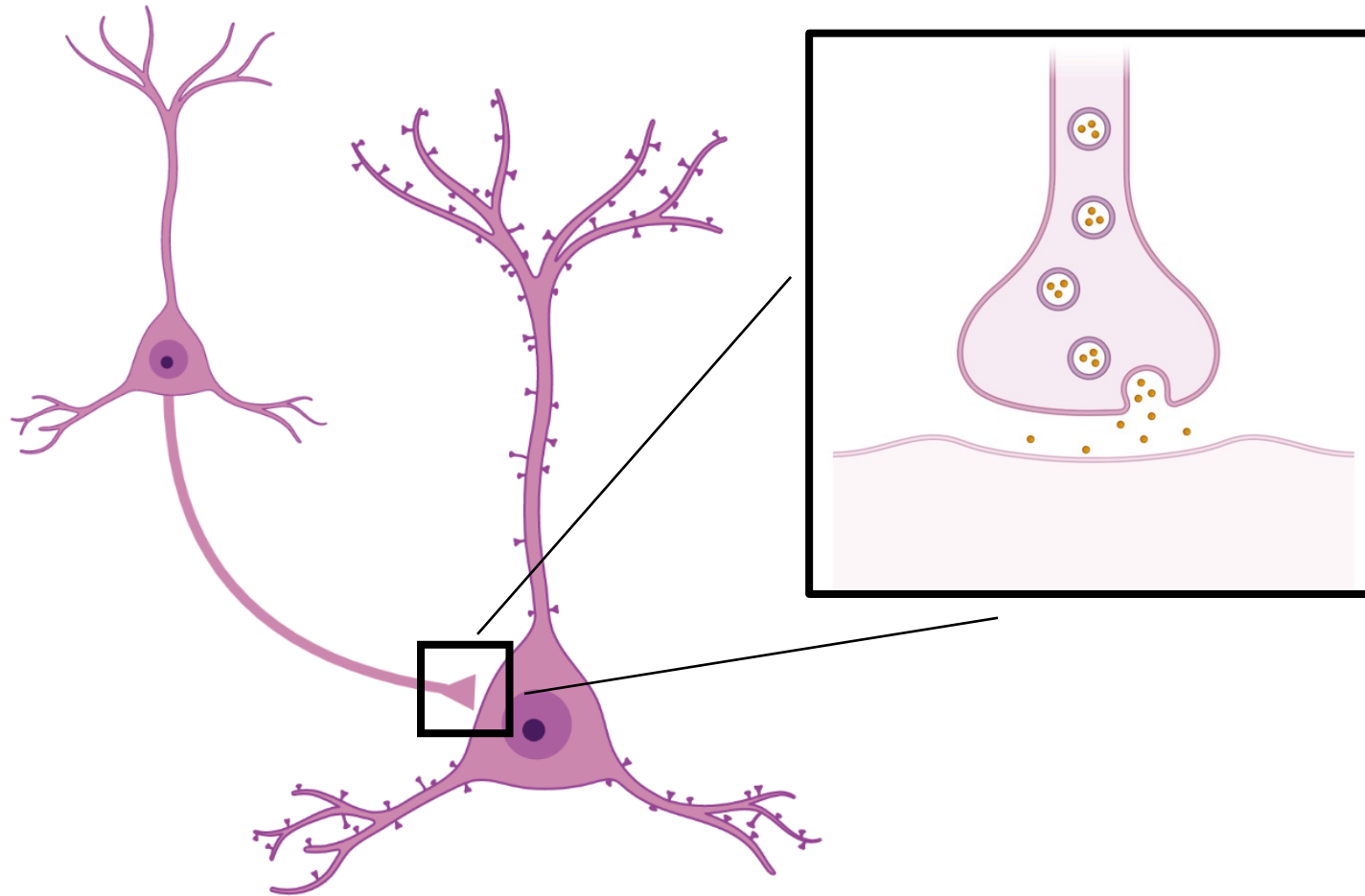
Neurons are the individual units of the nervous system



Santiago Ramón y Cajal
Nobel Prize in Physiology (1906)



Introduction to Neurobiological Context



- Individual neurons communicate with each other through ***synapses***.
- Synapses release neurotransmitters, such as ***GABA*** and ***glutamate***.
- These neurotransmitters cause specific channels to open on the postsynaptic neuron.

Schematics created with [BioRender.com](https://www.biorender.com/).

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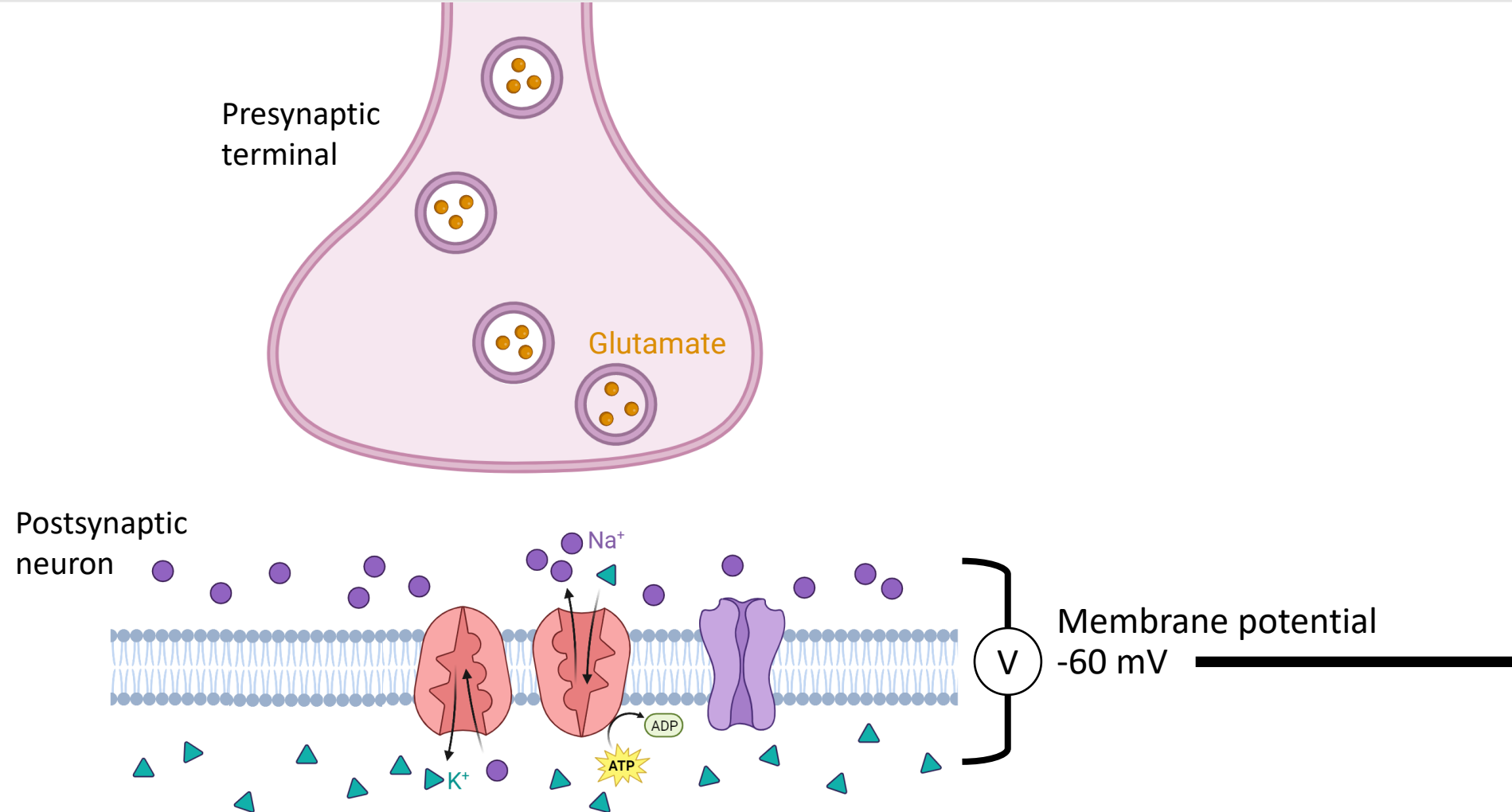
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Introduction to Neurobiological Context



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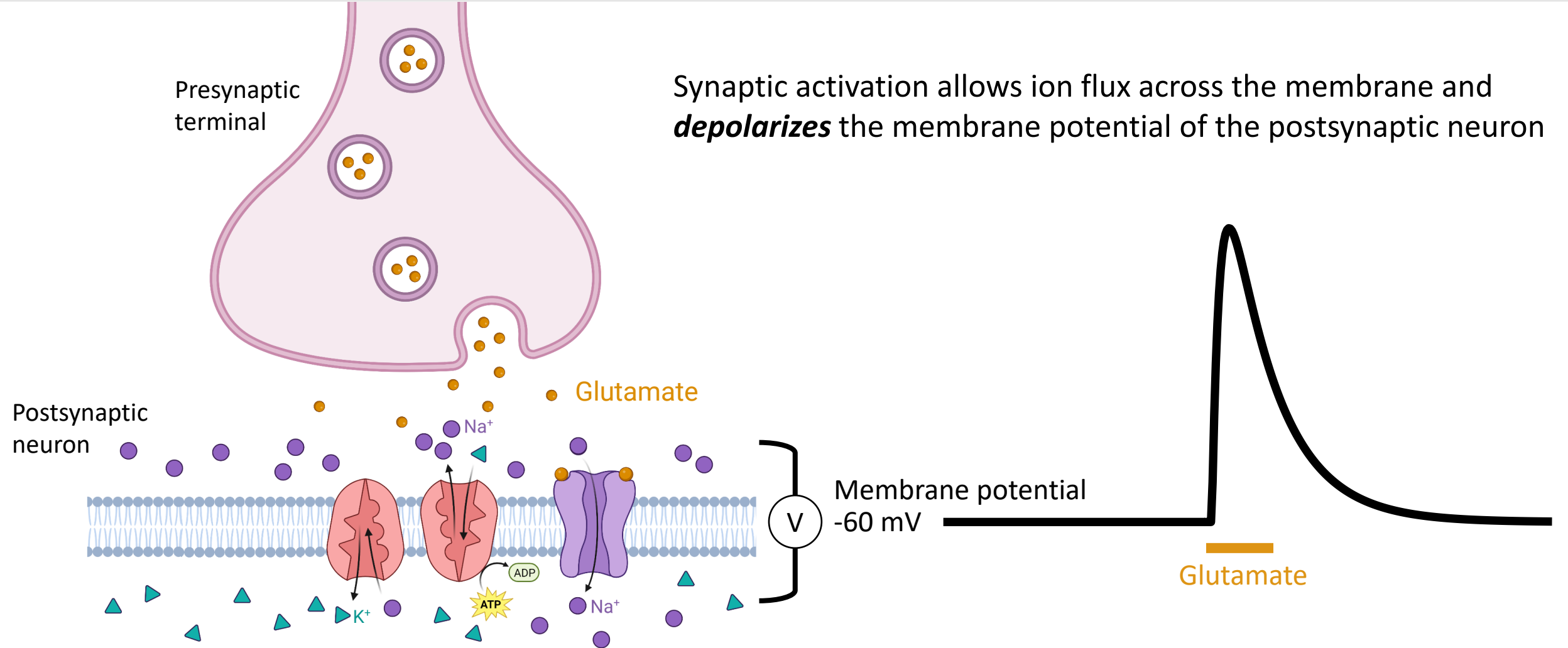
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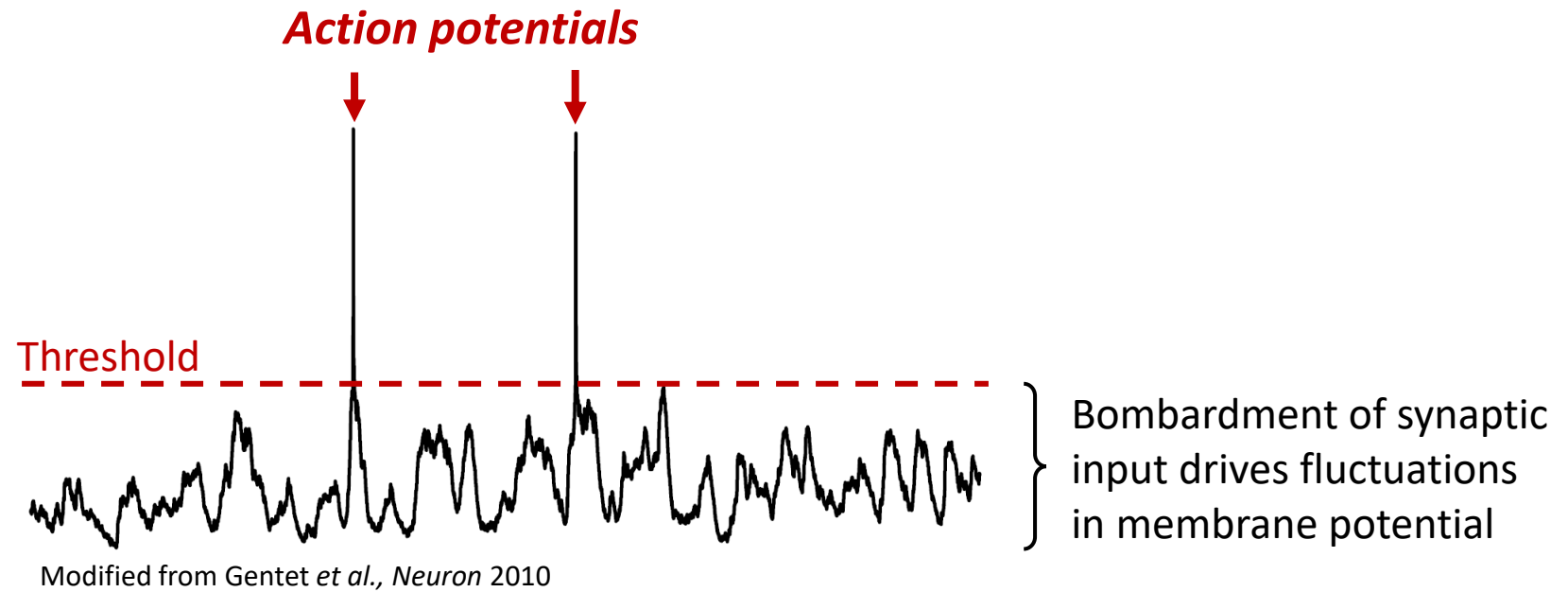
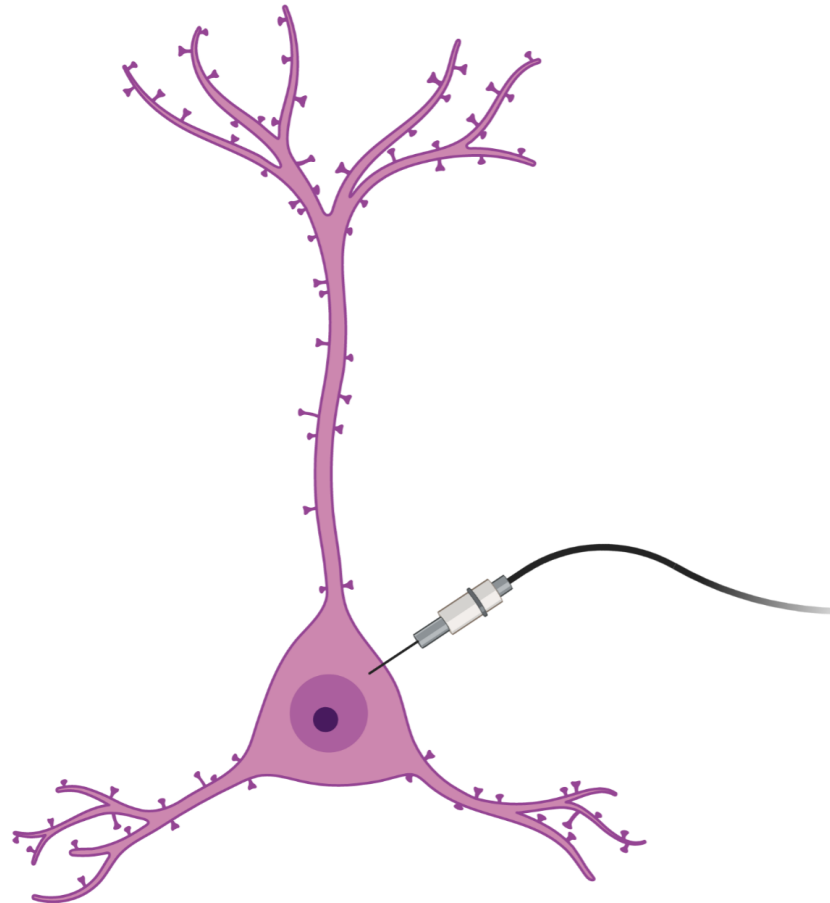
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Introduction to Neurobiological Context



A neuron in the cortex can receive input from $\sim 10,000$ synapses

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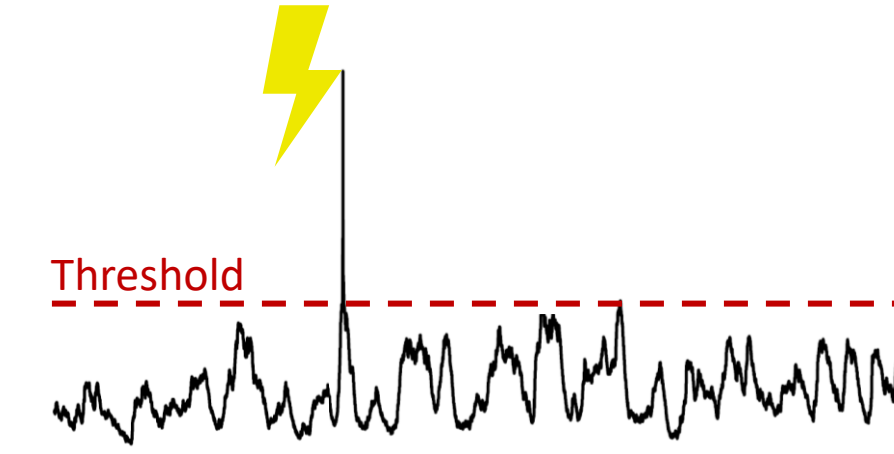
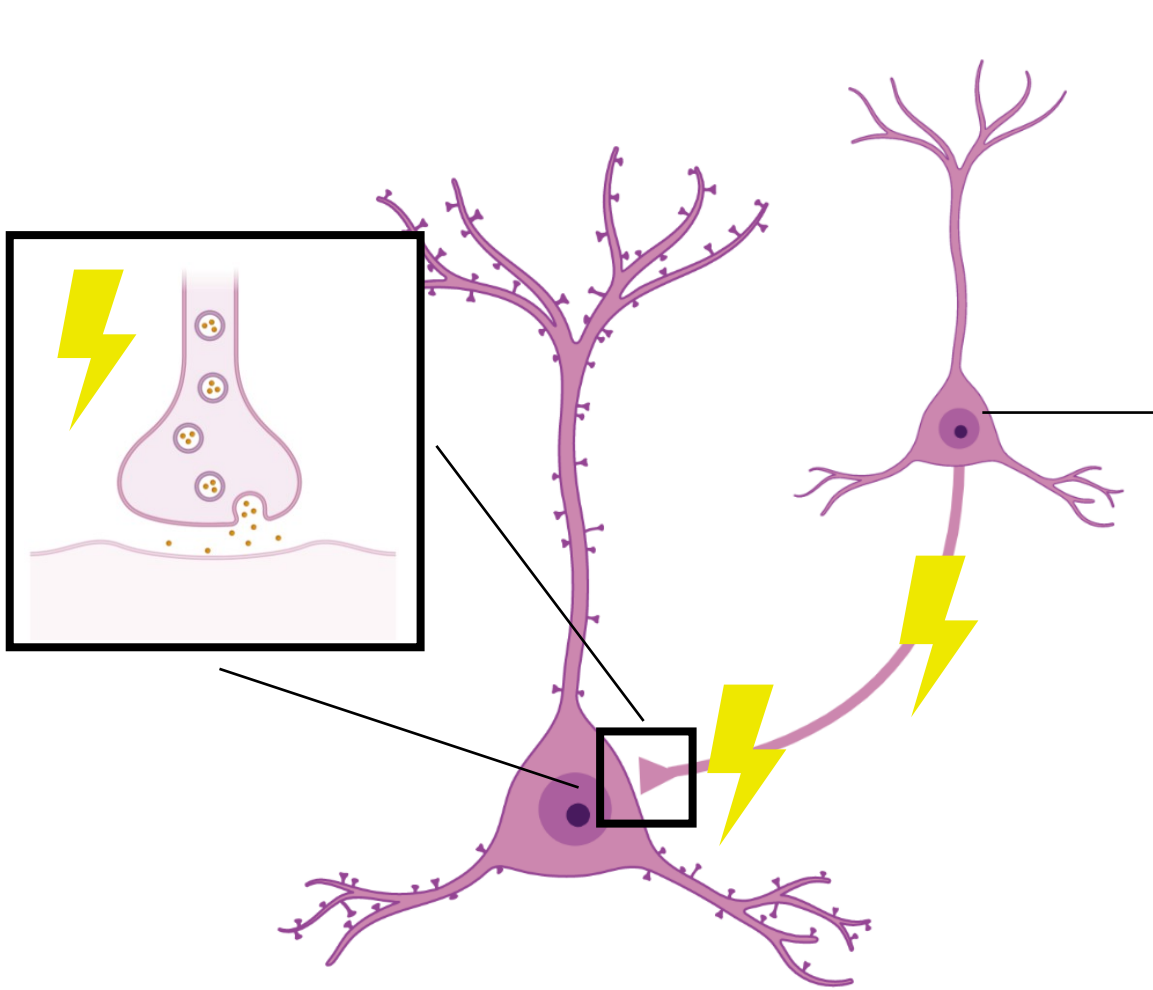
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Introduction to Neurobiological Context



- Action potentials are an all-or-none depolarization of a neuron
- Action potential firing causes neurotransmitter to be released onto a neuron's postsynaptic targets

The transformation of synaptic input into action potentials represents the fundamental computation of the nervous system

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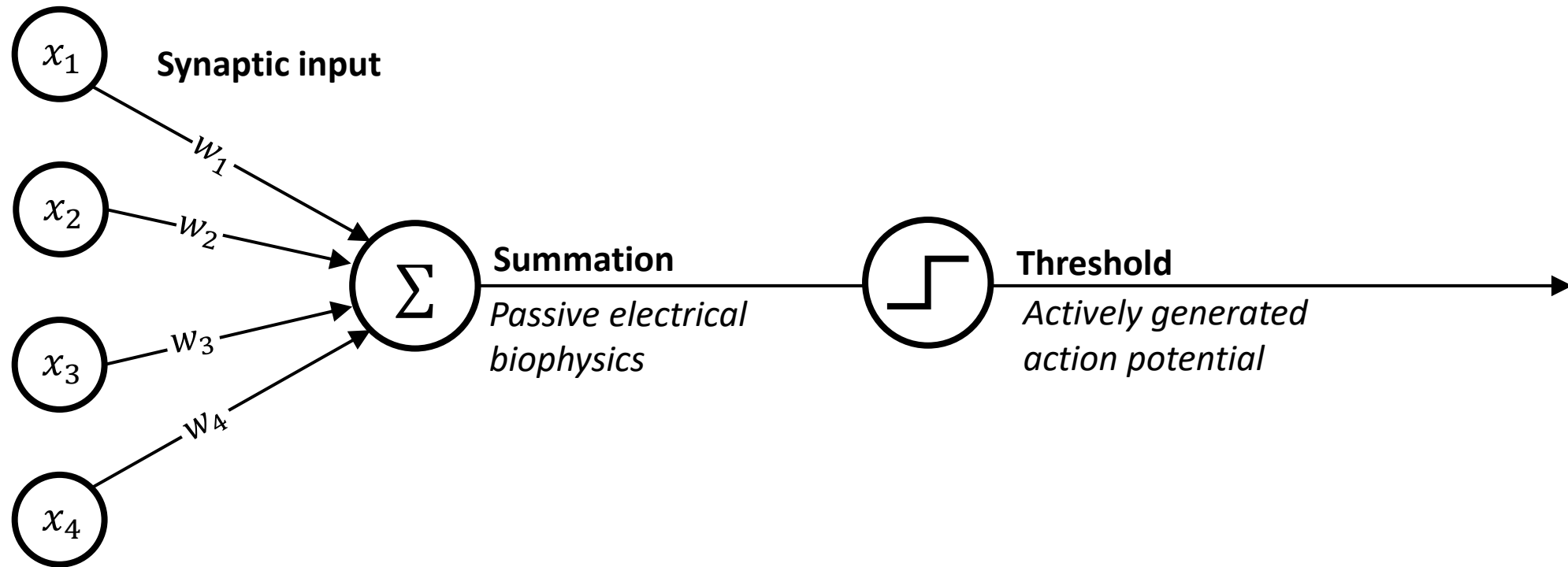


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Exploring Single Neuron Excitability with Mathematical and Computational Models

Introduction to Neurobiological Context

The fundamental computations of a neuron (simplified)



Introduction to Neurobiological Context

The fundamental computations of a neuron (less simplified)

