

# Propagation of Voltage in a Neuron

## The Cable Equation

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# Overview

1. Motivation
2. Neuronal Cable Equation
3. Passive Membrane (Linear Cable Equation)
4. Bi-stable Ion Channels

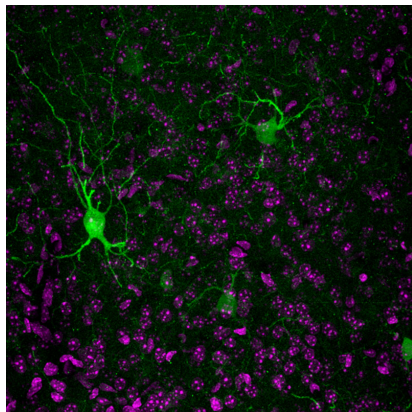
# How Do Neurons Communicate?

## Within one cell

- ▶ Electrochemical signals
- ▶ Membrane Potential:  
 $\Delta V_m = V_i - V_e$
- ▶ Ions: charge-carriers
- ▶ Ion Channels in Membrane

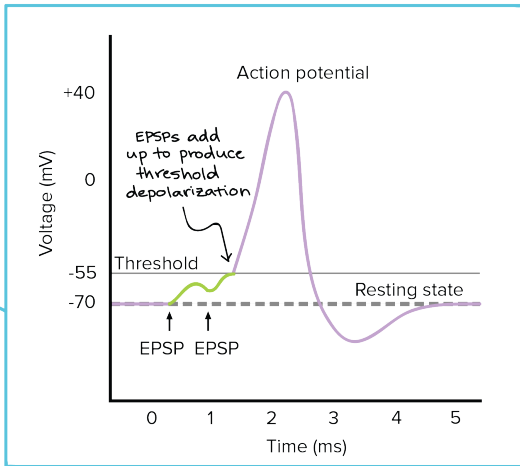
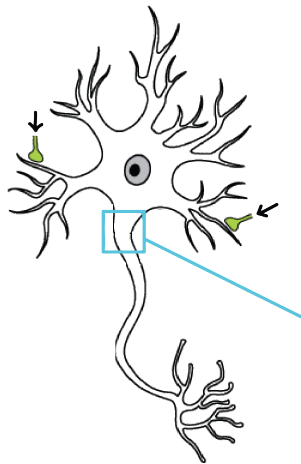
## Between cells

- ▶ Neurotransmitters



**Figure:** Mouse neurons, 40X. Bosch Institute Advanced Microscopy Facility, The University of Sydney

# Action Potentials



**Figure:** Changes in axonal membrane voltage due to an action potential.  
Image from Khan Academy

# Derivation of the Cable Equation

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# Passive Membrane

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# Green's Functions

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# Numerical Solutions

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# Traveling Wave Solutions

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# Speed of Traveling Wave

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# Stability of Traveling Wave

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# Numerical Solutions for Traveling Wave

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# Conclusion

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