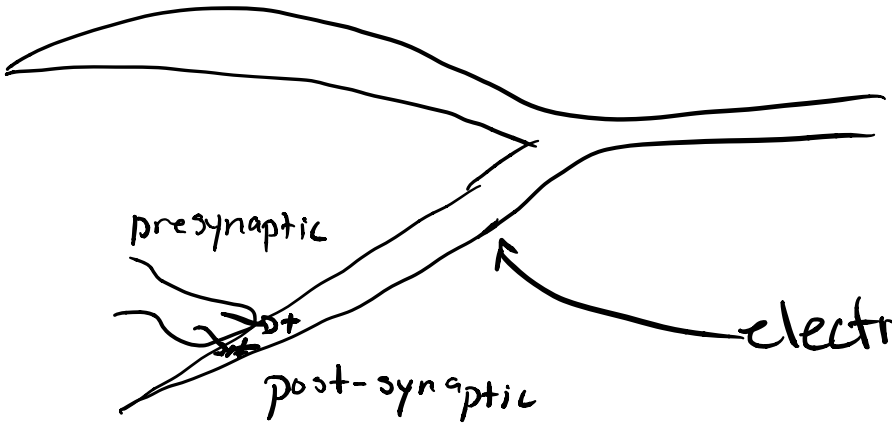
# Pre-Lecture Video

## Passive properties of neurons

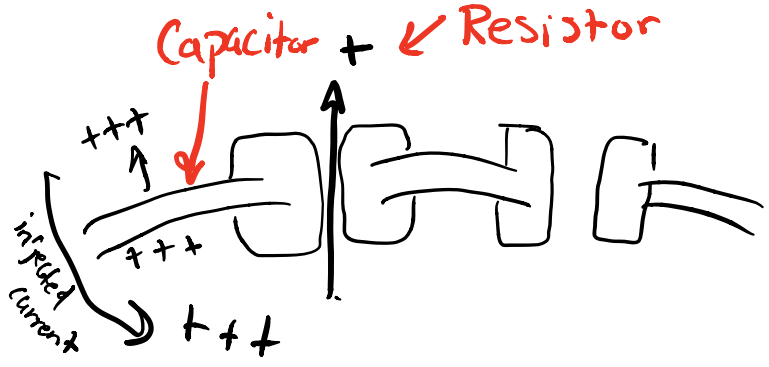



electrical properties

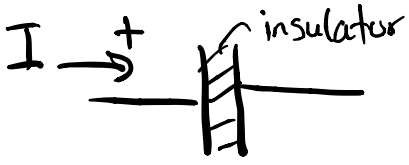
Speed of change in resting potential } depends on

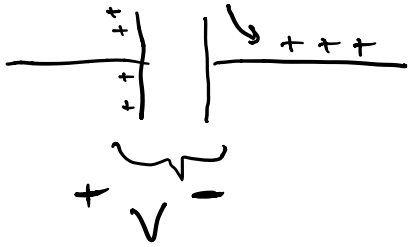
distance of effect post-synaptic cell

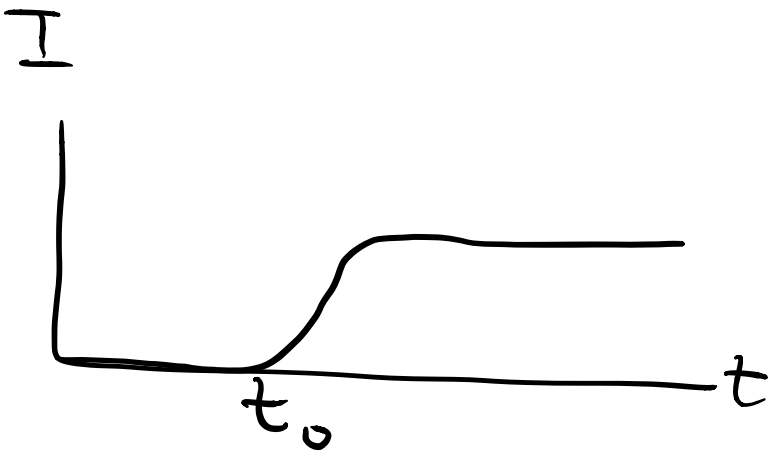
## Biological Model of

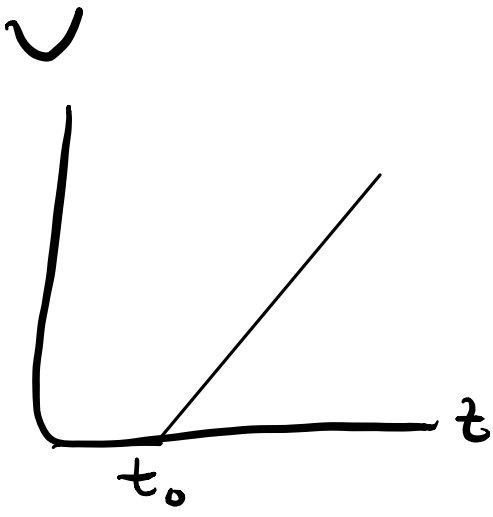


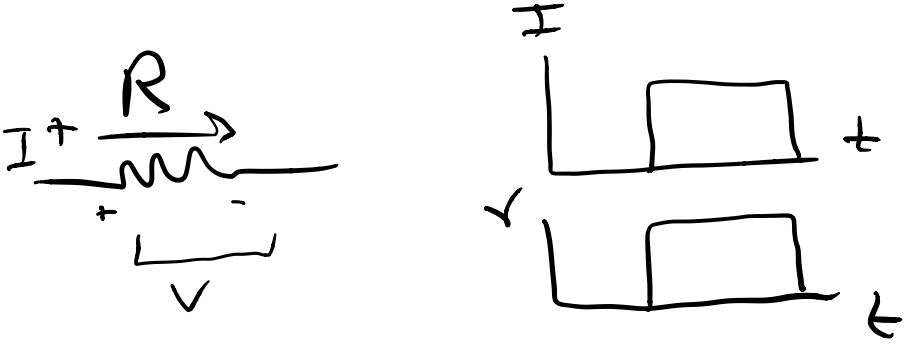

## Capacitors



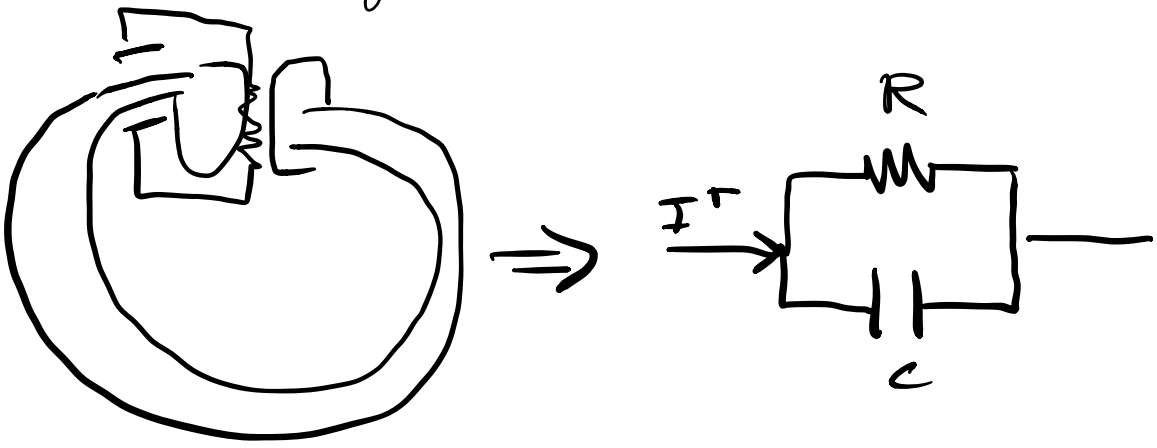



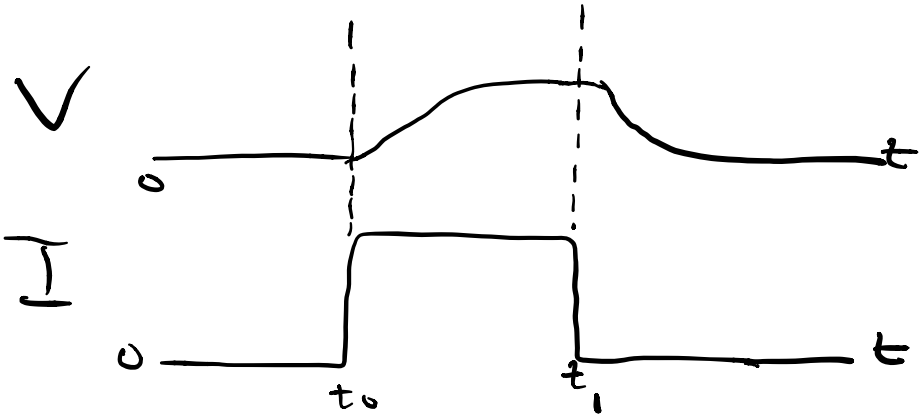



So for our biological model,



# Lecture 05. Action Potential and Propagation I

**Dr. Joseph Fetcho**

## Watch any pre-class video! Reading (less important than video)

Bear et al., pp. 82-84; 88-92, especially figures 4.1, 4.5, 4.6

## Lecture Objectives:

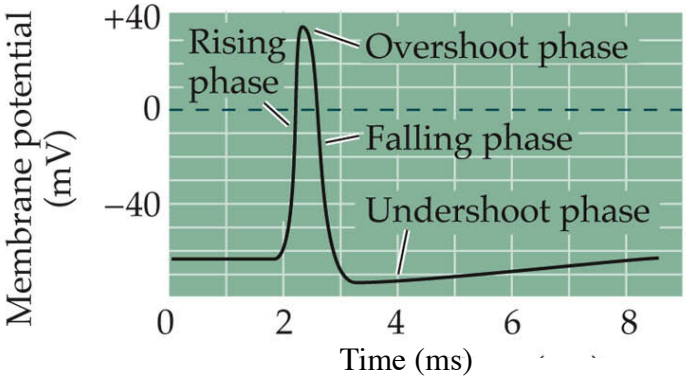
1. To learn the parts of an action potential. Be able to describe the different phases of the action potential.

2. To learn the properties of an action potential and how each arises by changes in conductances to different ions. Be able to describe how conductance changes and current flows give rise to each phase of the action potential

3. To learn how the voltage clamp technique revealed the permeability changes to ions that underlie the action potential.

## Lecture Outline

1. **Why action potentials?**
We saw earlier that recordings from neurons reveal very large, stereotypic events called action potentials. If we record from an axon of a motoneuron at different locations along the axon's path out to muscle we would see action potentials at each location, with some delay as we move farther along the axon. Action potentials are important because passive properties of neurons lead to the decay of the changes in membrane potential over long distances. In order to have electrical changes in the cell body of a motoneuron in the spinal cord transmitted out to the muscle, the signal needs to be amplified or regenerated along the way, much like the boosting of radio or cell phone transmission. Action potentials do this. We will explore how… the answer led to a Nobel prize.




2. **Features of Action potentials that need explanation,**

A. Waveform of the action potential. Rising phase (depolarizing), overshoot, falling

phase (repolarizing), undershoot (hyperpolarizing).

B. Triggered by a depolarization.

C. The membrane needs to be depolarized to a certain level, or threshold, and then suddenly a full-blown action potential is produced.

D. Action potentials are all or none.

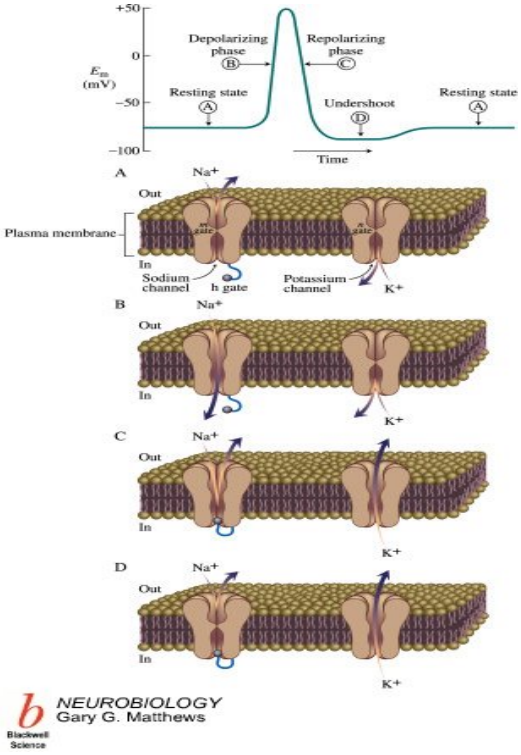
E. At the peak of the action potential the inside of the neuron is positive.

F. After an action potential there is a brief time (about 1 millisecond), called the absolute refractory period. when it is impossible to trigger another action potential.

G. Action potentials propagate without decrement along axons, although at fairly low speeds (10-100m/sec).

3. **Manipulations of external concentrations of sodium and potassium point to changes in the conductance of each as a possible explanation for the generation of the action potential.**

4. **The waveform of the action potential is explained by voltage dependent changes in the conductance to sodium and potassium, as revealed by voltage clamp experiments by Hodgkin and Huxley.**




5. **Overview of how channels in the membrane are opening and closing in response to the voltage.** Two gates in the sodium channel (m and h) and one (n) in the potassium channel (refer to animation posted on Blackboard).

## Study Questions:

1. What are the different parts of an action potential and how are the ion permeabilities changing during them?

2. Describe in words what a voltage clamp does and why it was critical for revealing the currents flowing during an action potential.

$\lambda = \sqrt{r_m / r_i}$

$\uparrow r_m$ myelination

$\downarrow r_i$ bigger diameter axon