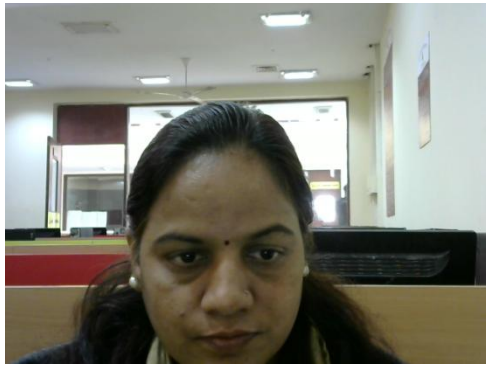
Inhibitory Post Synaptic Potential

(IPSP)



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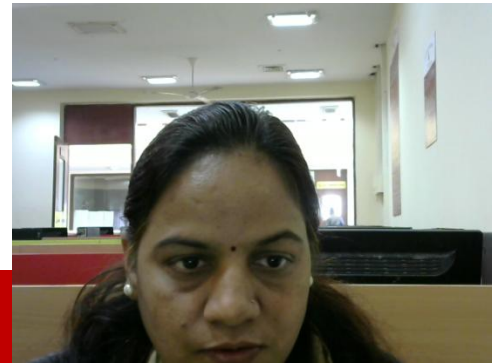
Recaptulation

Cell Membrane

Chemical composition and its structural plan

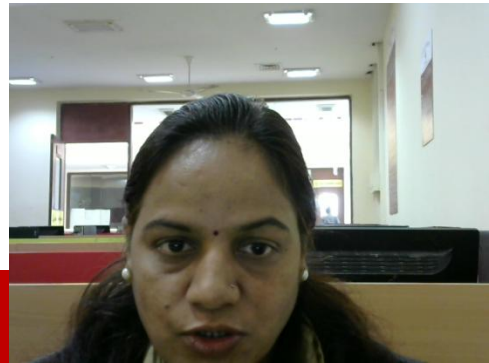
- Model of cell membrane: Fluid Mosaic Model
- Membrane fluidity,Functions of cell membrane
- Physiology in detail



Objectives

Inhibitory Post Synaptic Potential

(IPSP)



video

Microsoft Teams

BIOLOGY FOR ENGINEERS

2020-12-02 11:11 UTC

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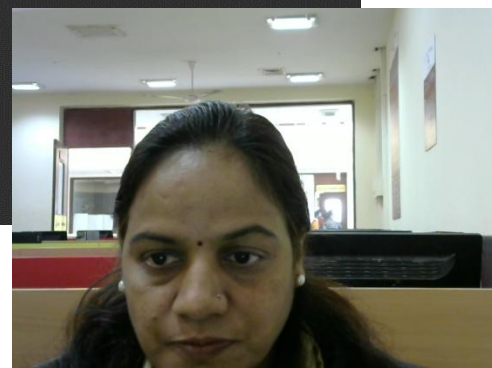
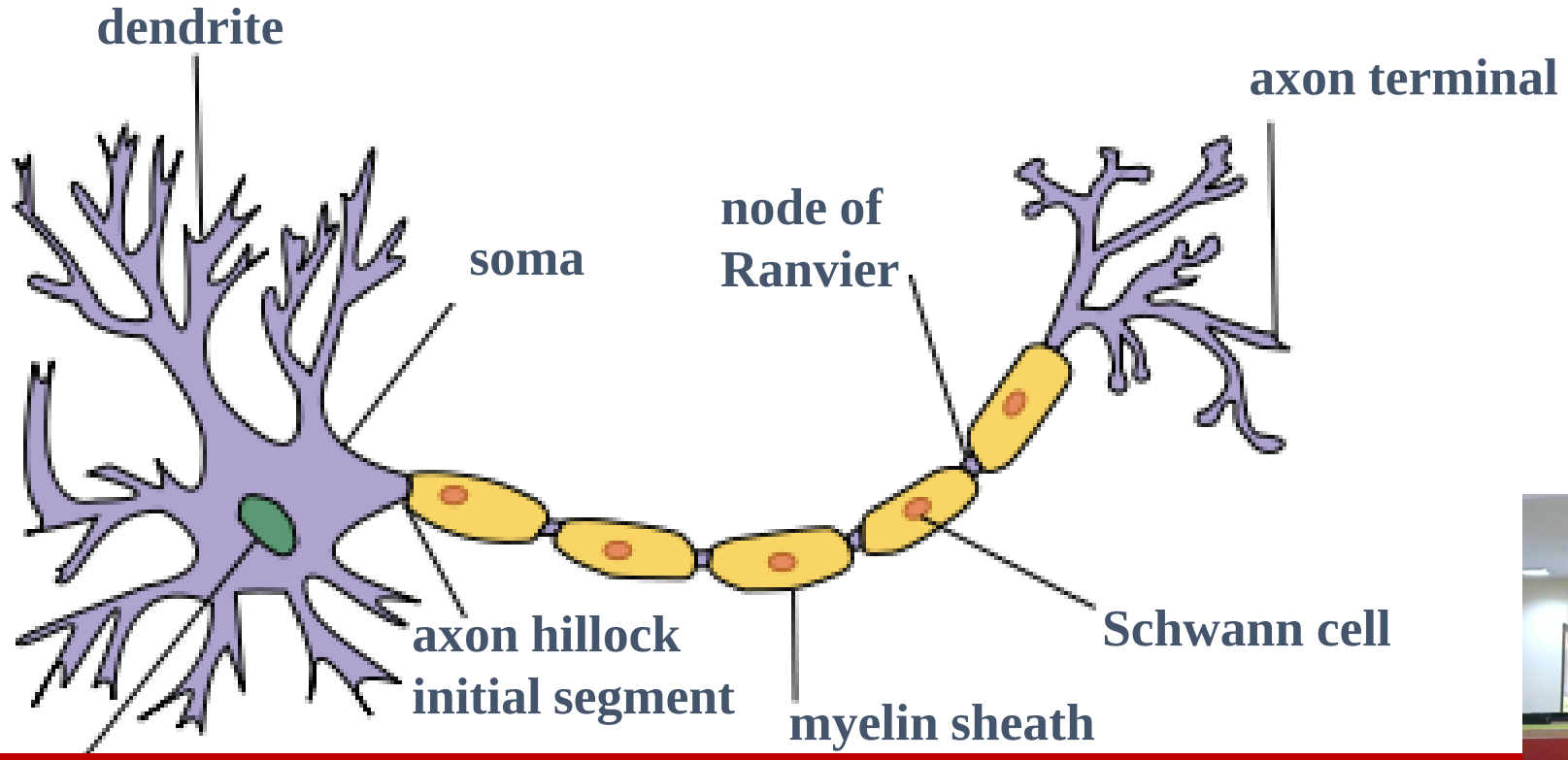
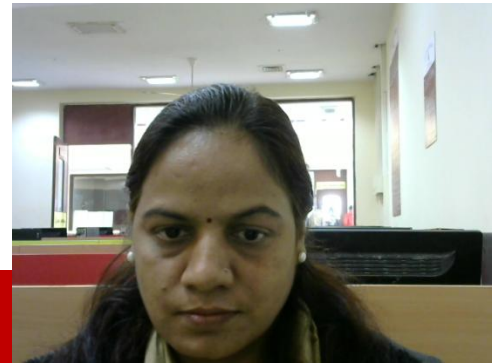


NEURON

Excitable tissues - neuron (nerve tissue)
- muscle fiber (muscle tissue)

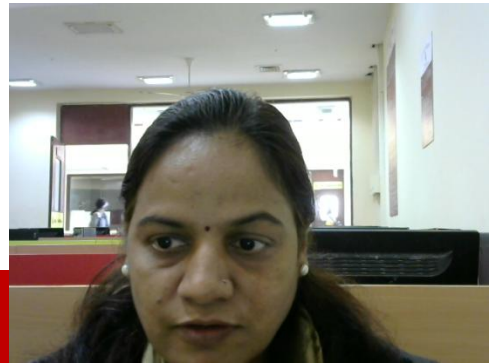
Neuron - primary structural and functional unit of nerve tissue
(brain, spinal cord, nerves, sensory cells)





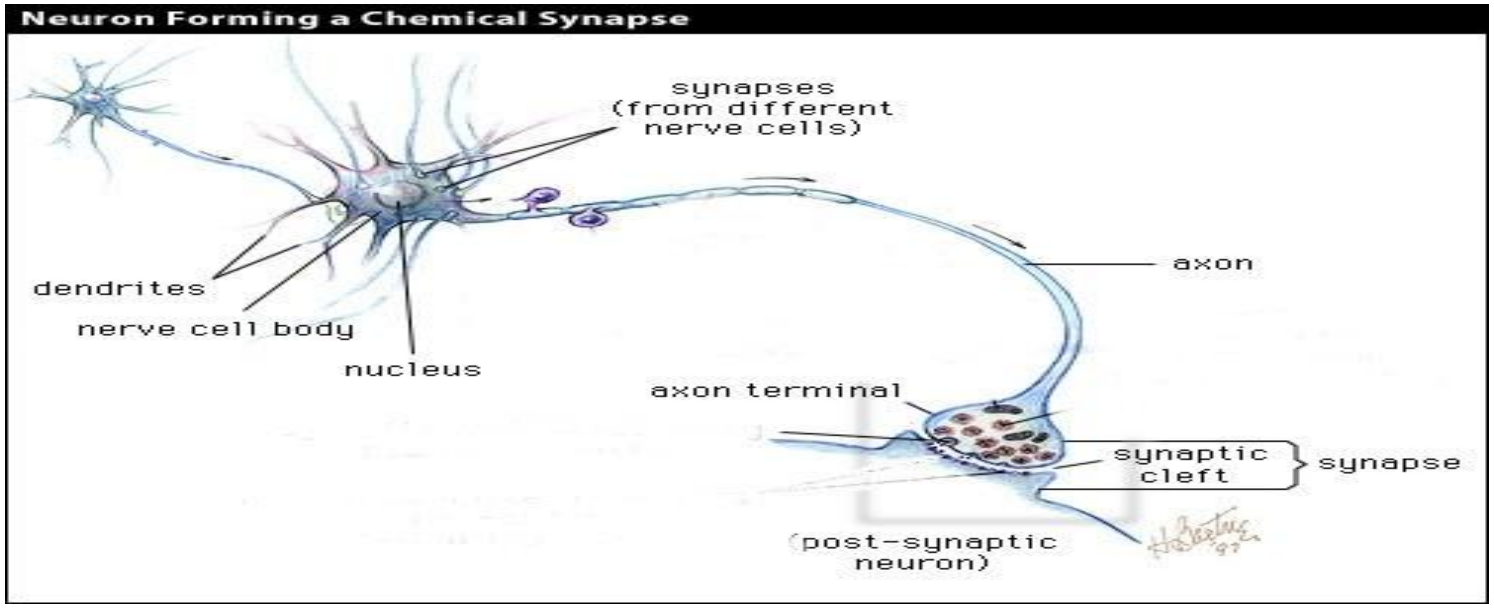
NEURON

- *cell body*
- *dendrites (input structure)*
  - *receive inputs from other neurons*
  - *perform spatio-temporal integration of inputs*
  - *relay them to the cell body*
- *axon (output structure)*
  - *a fiber that carries messages (spikes) from the cell to dendrites of other neurons*



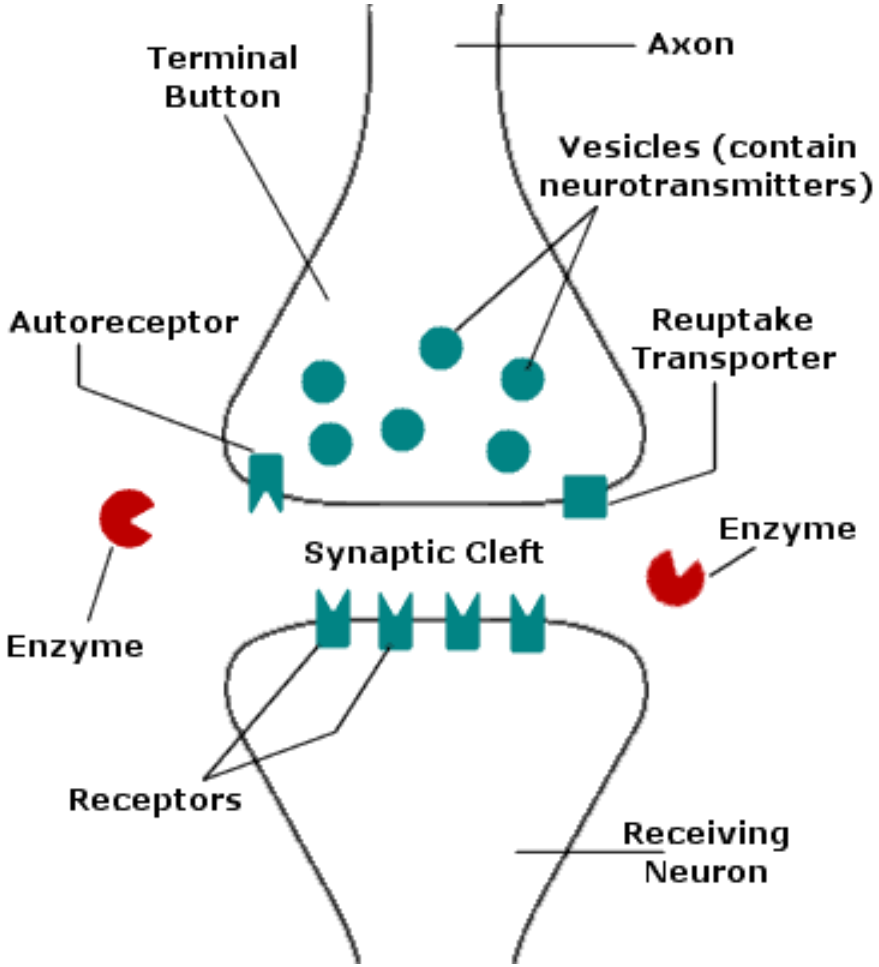
Synapse

formed when an axon of a presynaptic cell "connects" with the dendrites of a postsynaptic cell



postsynaptic neuron

Synapse



axon of presynaptic neuron

dendrite of postsynaptic neuron

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Synapse

site of communication between two cells

formed when an axon of a presynaptic cell "connects" with the dendrites of a postsynaptic cell

a synapse can be excitatory or inhibitory

arrival of activity at an excitatory synapse depolarizes the local membrane potential of the postsynaptic cell and makes the cell more prone to firing

arrival of activity at an inhibitory synapse hyperpolarizes the local membrane potential of the postsynaptic cell and makes it less prone to firing

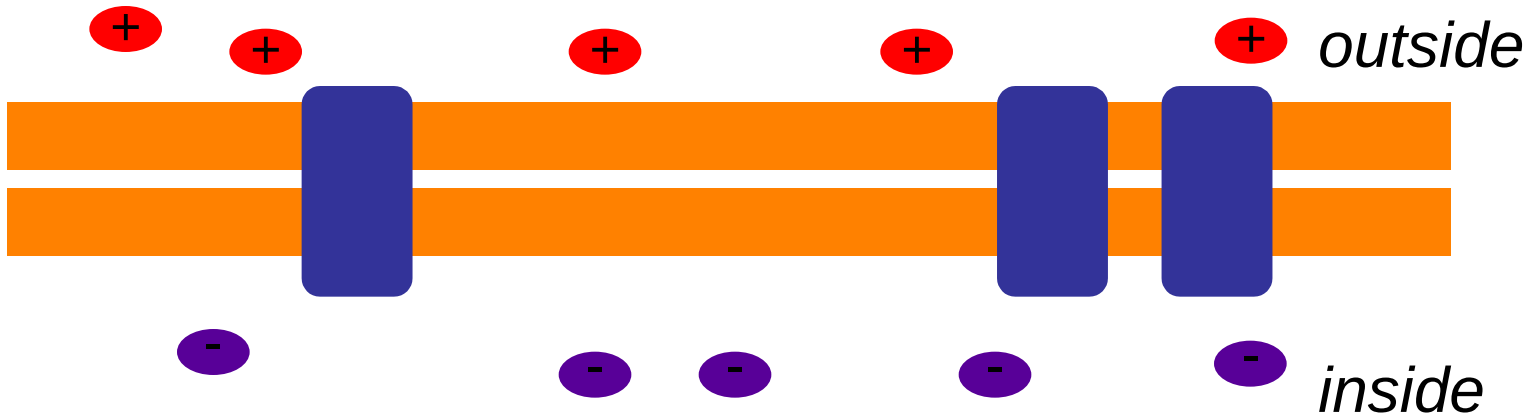
the greater the synaptic strength, the greater the depolarization or hyperpolarization

The Membrane

- It is composed of **lipid** and **protein**.
- The **membrane** surrounds the neuron.

The Resting Potential

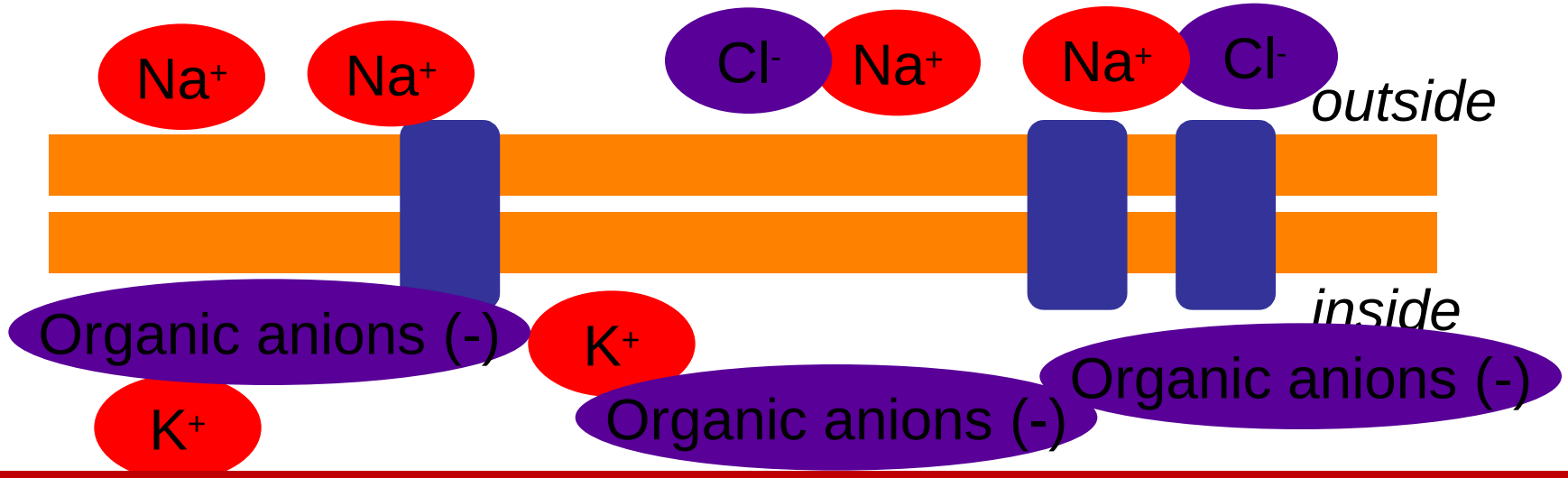
- There is an **electrical charge** across the membrane.
- This is the **membrane potential**.
- The **resting potential** (when the cell is not firing) is a 70mV difference between the inside and the outside.



Resting potential of neuron = -70mV

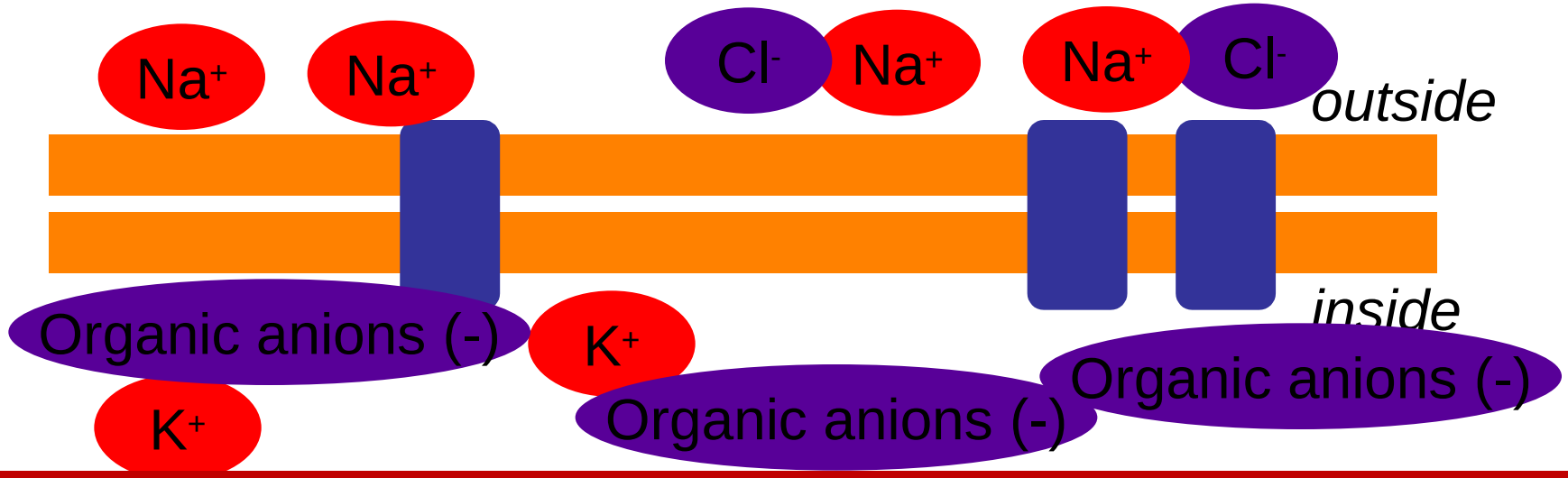
Ions potential and Resting Potential

- Ions are **electrically-charged molecules** e.g. sodium (Na+), potassium (K+), chloride (Cl-).
- The resting potential due to the **ions which** are **concentrated** on different sides of the membrane.
  - **Na^+** and **Cl^-** outside the cell.
  - **K^+** and **organic anions** inside the cell.



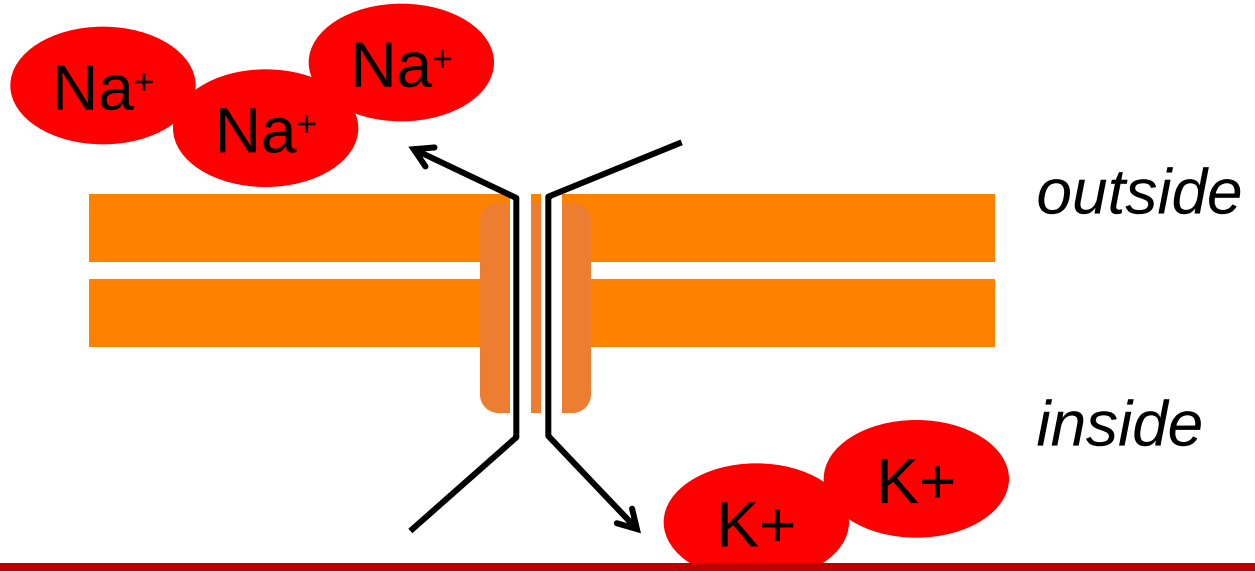
Ions potential and Resting Potential

- Ions are **electrically-charged molecules** e.g. sodium (Na+), potassium (K+), chloride (Cl-).
- The resting potential exists because **ions** are **concentrated** on different sides of the membrane.
  - **Na^+** and **Cl^-** outside the cell.
  - **K^+** and **organic anions** inside the cell.



Maintaining the Resting Potential

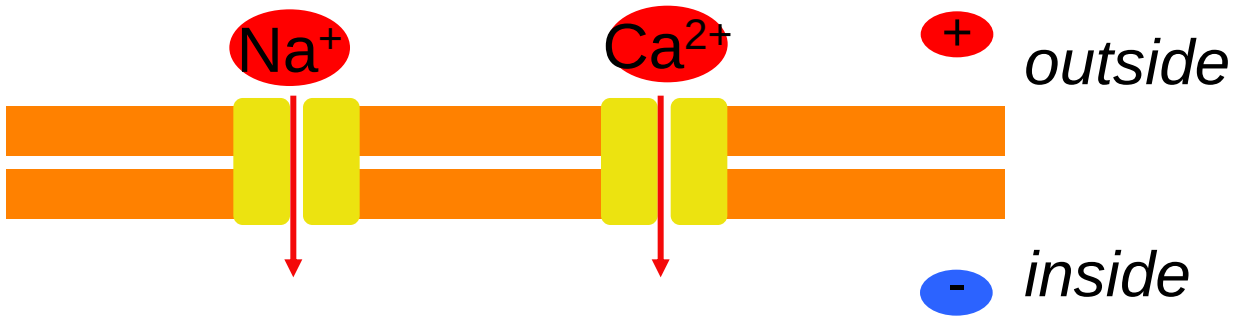
- Na+ ions are **actively transported** (this uses energy) to maintain the resting potential.
- The **sodium-potassium pump** (a membrane protein) exchanges three Na^+ ions for two K^+ ions.



Maintaining the Resting Potential

(EPSPs)

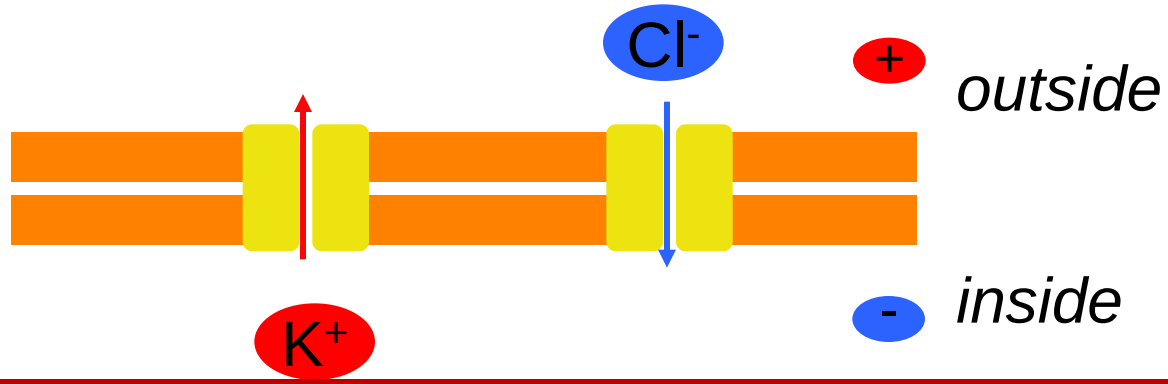
- Opening of ion channels which leads to **depolarization** makes an action potential *more likely*, hence "excitatory PSPs": **EPSPs.**
  - Inside of post-synaptic cell becomes **less negative**.
  - **Na^+ channels** *(NB remember the action potential)*
  - **Ca^{2+}** . (Also activates structural intracellular changes -> learning.)



Maintaining the Resting Potential

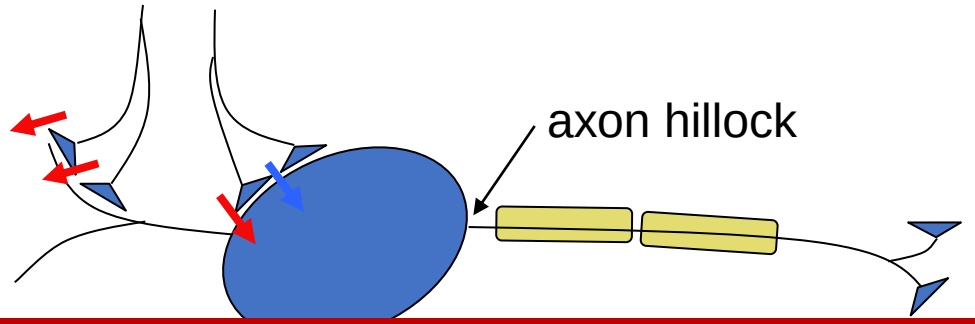
(IPSPs)

- Opening of ion channels which leads to **hyperpolarization** makes an action potential *less likely*, hence "inhibitory PSPs": **IPSPs.**
  - Inside of post-synaptic cell becomes **more negative**.
  - **K^+** *(NB remember termination of the action potential)*
  - **Cl^-** (if already depolarized)



Integration of information

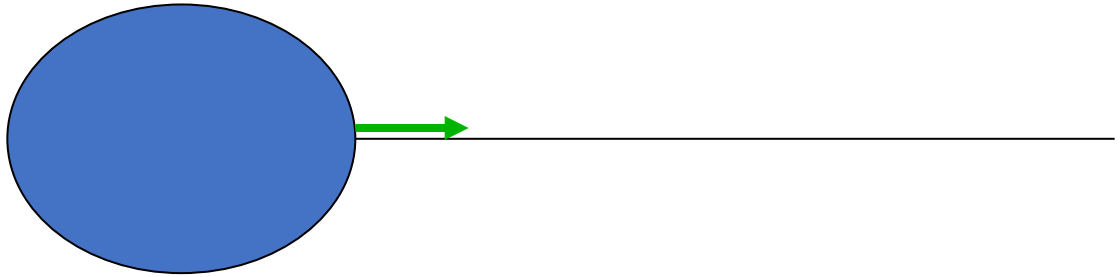
- PSPs are small. An individual EPSP will not produce enough depolarization to trigger an action potential.
- IPSPs will counteract the effect of EPSPs at the same neuron.
- **Summation** means the effect of many coincident IPSPs and EPSPs at one neuron.
- If there is sufficient depolarization at the **axon hillock**, an action potential will be triggered.



references

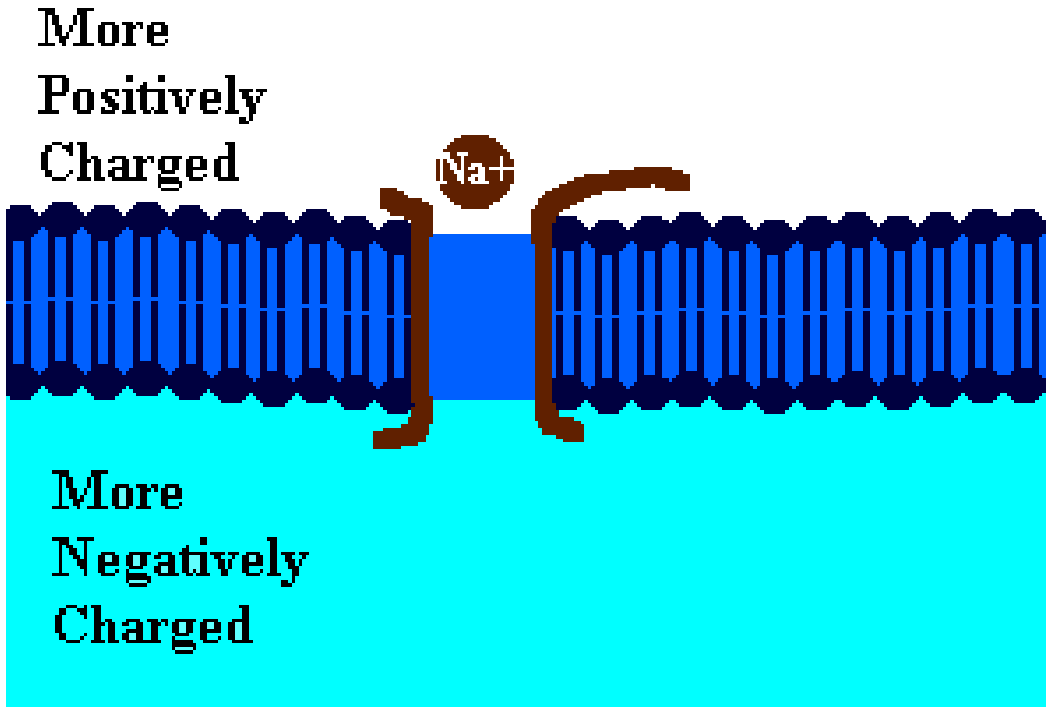
Neuronal firing: the action potential

- The **action potential** is a rapid **depolarization** of the membrane.
- It starts at the **axon hillock** and passes quickly along the **axon**.
- The membrane is quickly **repolarized** to allow subsequent firing.



Maintaining the Resting Potential

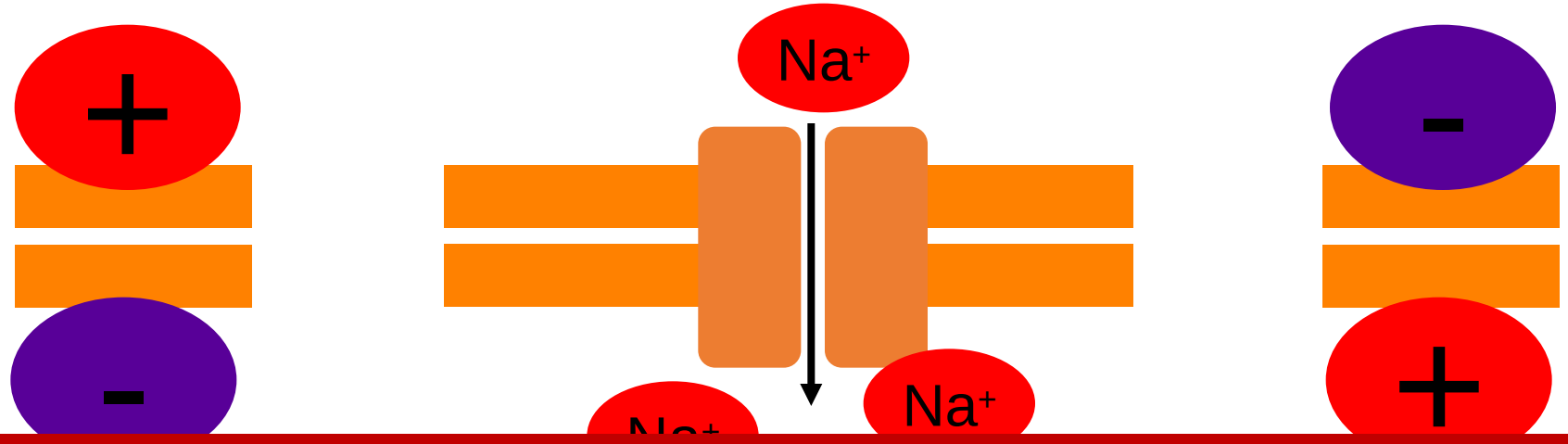
Before Depolarization



Maintaining the Resting Potential

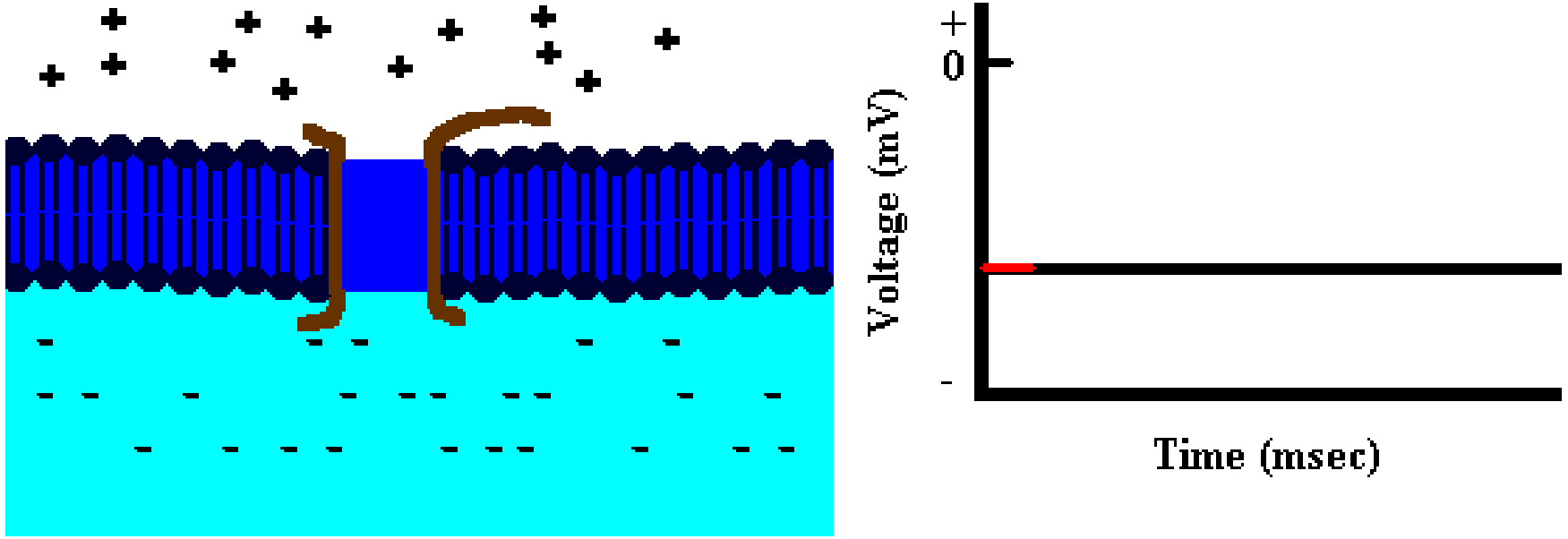
Action potentials: Rapid depolarization

- When partial depolarization reaches the **activation threshold, voltage-gated sodium ion channels** open.
- Sodium ions rush in.
- The membrane potential changes from -70mV to +40mV.



Maintaining the Resting Potential

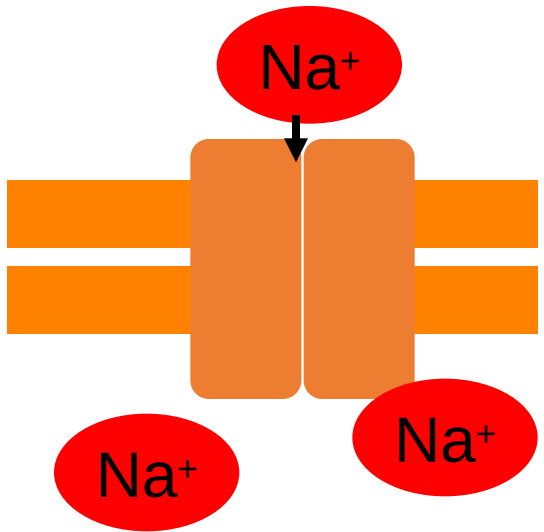
Depolarization

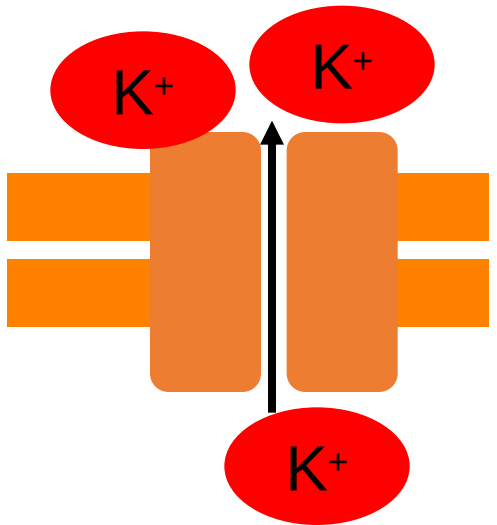


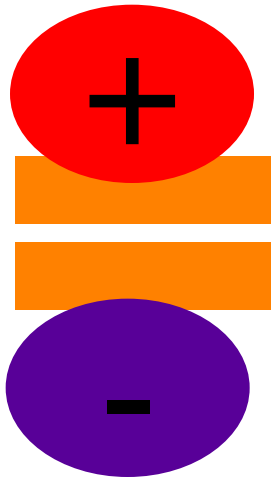
Maintaining the Resting Potential

Action potentials: Repolarization

- Sodium ion channels close and become **refractory**.
- Depolarization triggers opening of **voltage-gated potassium ion channels.**
- **K+** ions rush out of the cell, repolarizing and then hyperpolarizing the membrane.

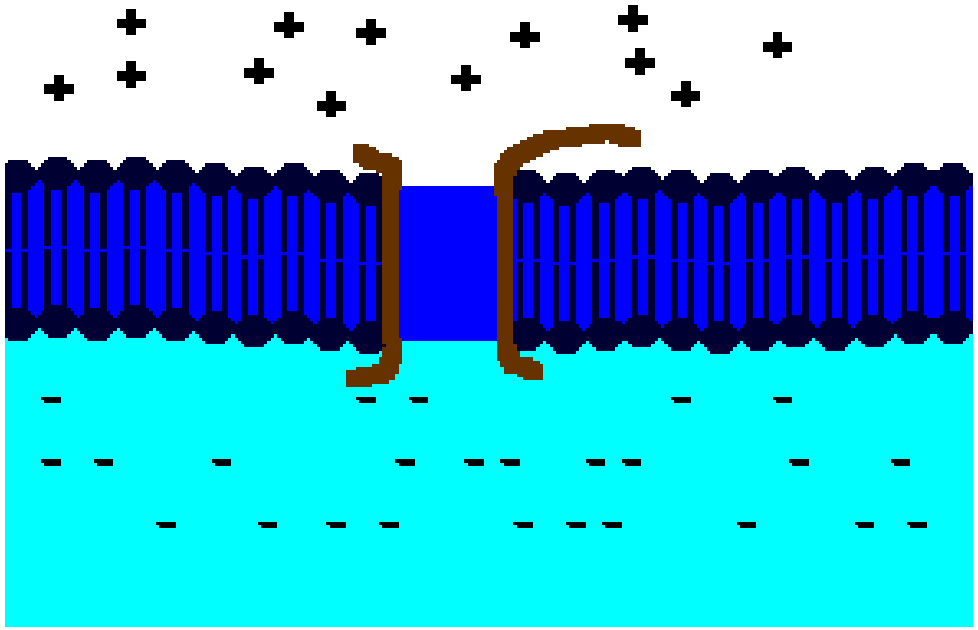


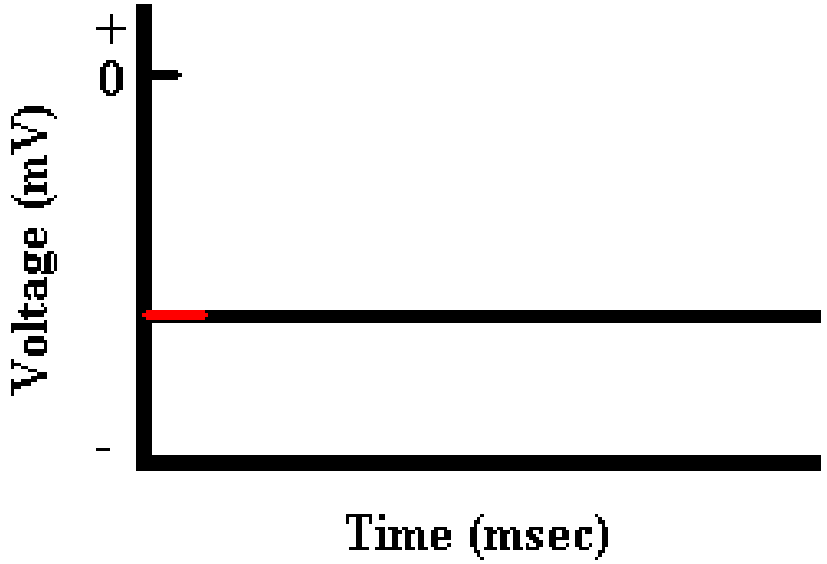




Maintaining the Resting Potential

Repolarization





Maintaining the Resting Potential

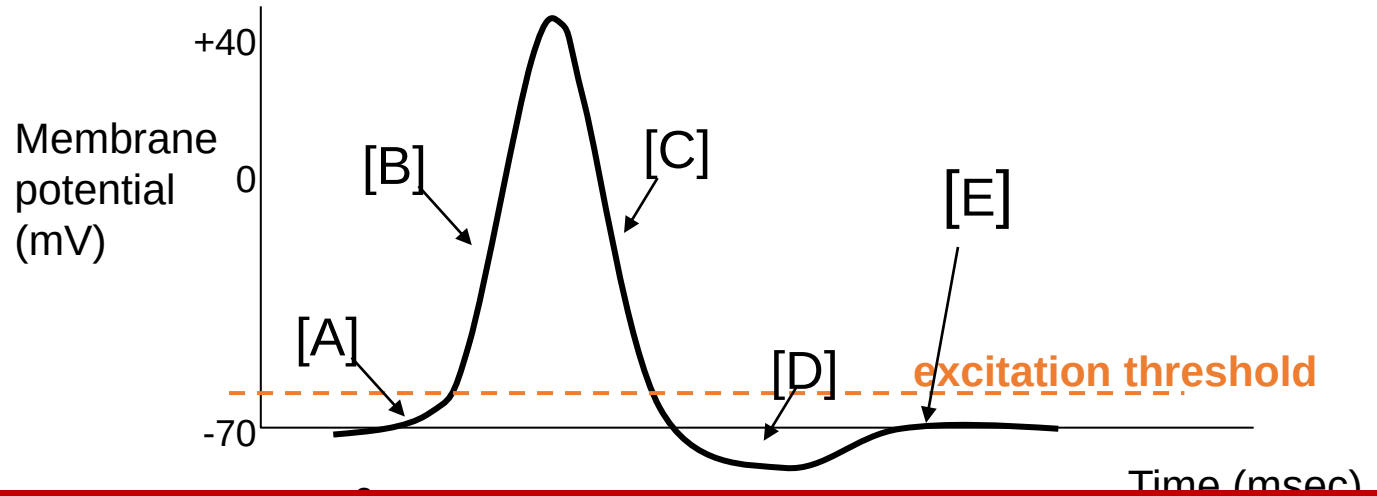
The Action Potential

- The action potential is **“all-or-none”**.
- It is always the same size.
- Either it is not triggered at all - e.g. too little depolarization, or the membrane is “refractory”;
- Or it is triggered completely.

Maintaining the Resting Potential

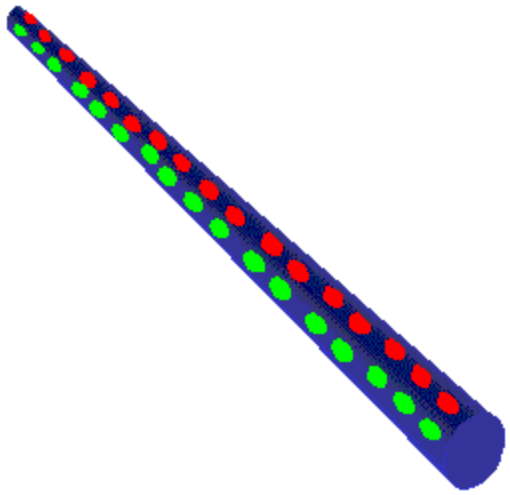
Course of the Action Potential

- The action potential begins with a **partial depolarization** (e.g. from firing of another neuron) [A].
- When the **excitation threshold** is reached there is a sudden large **depolarization** [B].
- This is followed rapidly by **repolarization** [C] and a brief **hyperpolarization** [D].
- There is a **refractory period** immediately after the action potential where no depolarization can occur [E]



Maintaining the Resting Potential

Action Potential



Local Currents depolarize adjacent channels causing depolarization and opening of adjacent Na channels

Question: Why doesn't the action potential travel backward?

Conduction of the action potential.

- **Passive conduction** will ensure that adjacent membrane depolarizes, so the action potential “travels” down the axon.
- But transmission by continuous action potentials is relatively **slow** and **energy-consuming** (Na^+/K^+ pump).
- A faster, more efficient mechanism has evolved: **saltatory conduction.**
- **Myelination** provides saltatory conduction.