Membrane Potential, Action Potential and Ion Channels

Lecture 6

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Membrane potential

Membrane potentials in cells are determined primarily by three factors:

1) the concentration of ions on the inside and outside of the cell;

2) the permeability of the cell membrane to those ions (i.e., ion conductance) through specific ion channels;

3) by the activity of **electrogenic** pumps (e.g., Na^+/K^+-ATPase and Ca^{++} transport pumps) that maintain the ion concentrations across the membrane.

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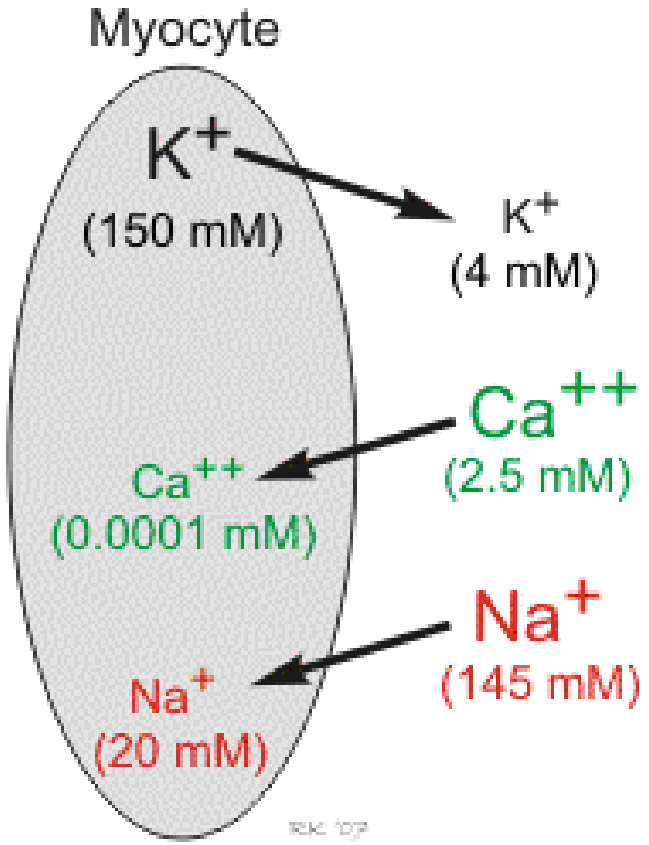

Membrane potential

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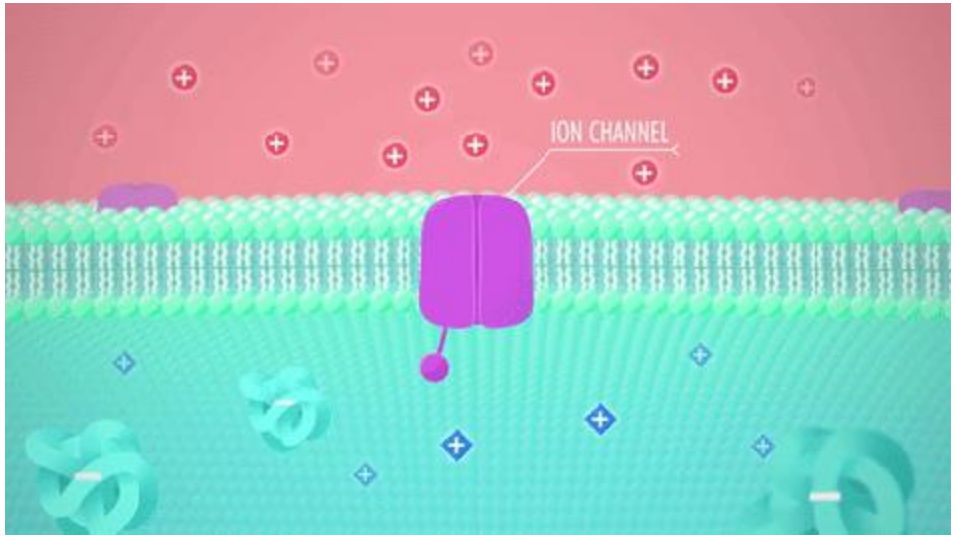

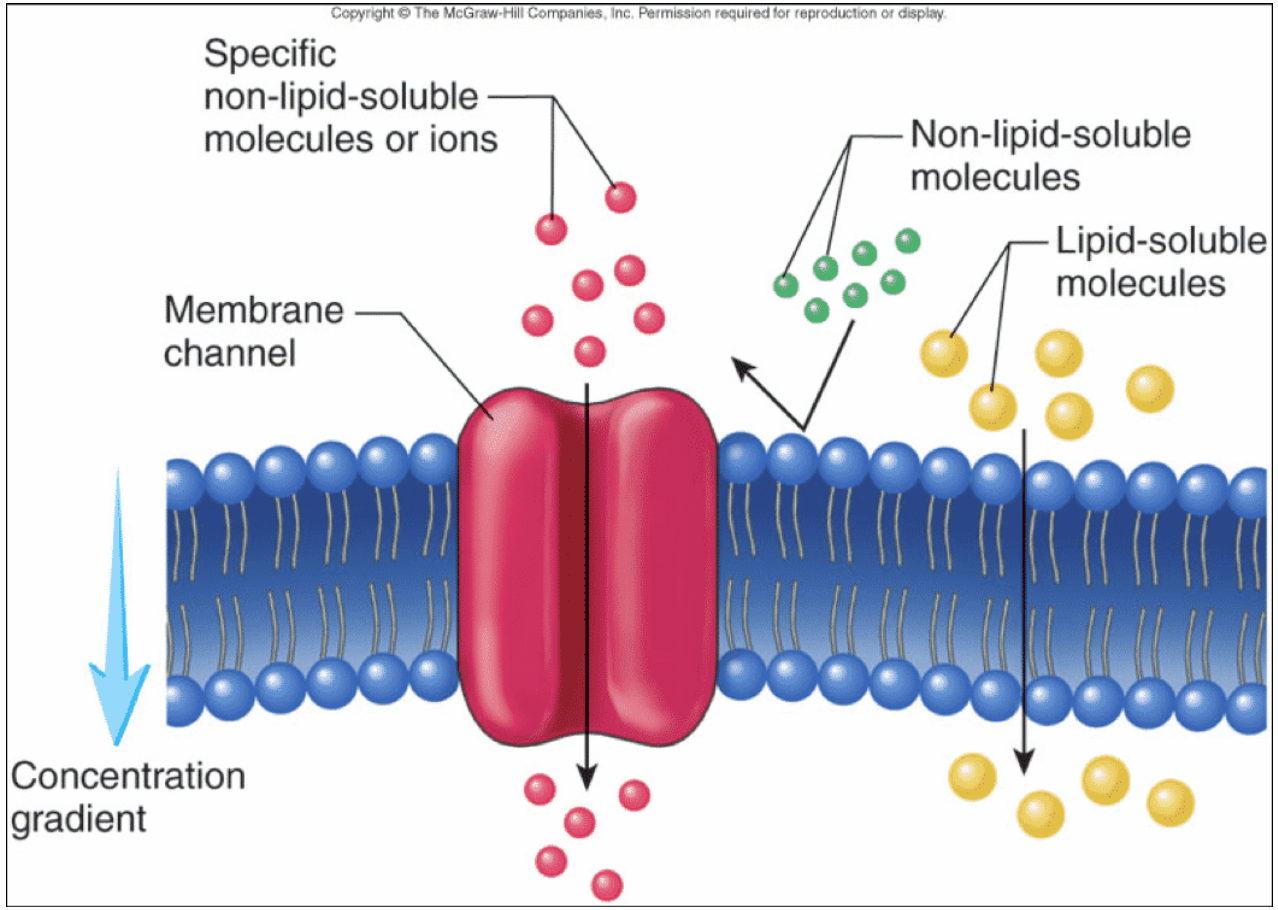
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Membrane potential

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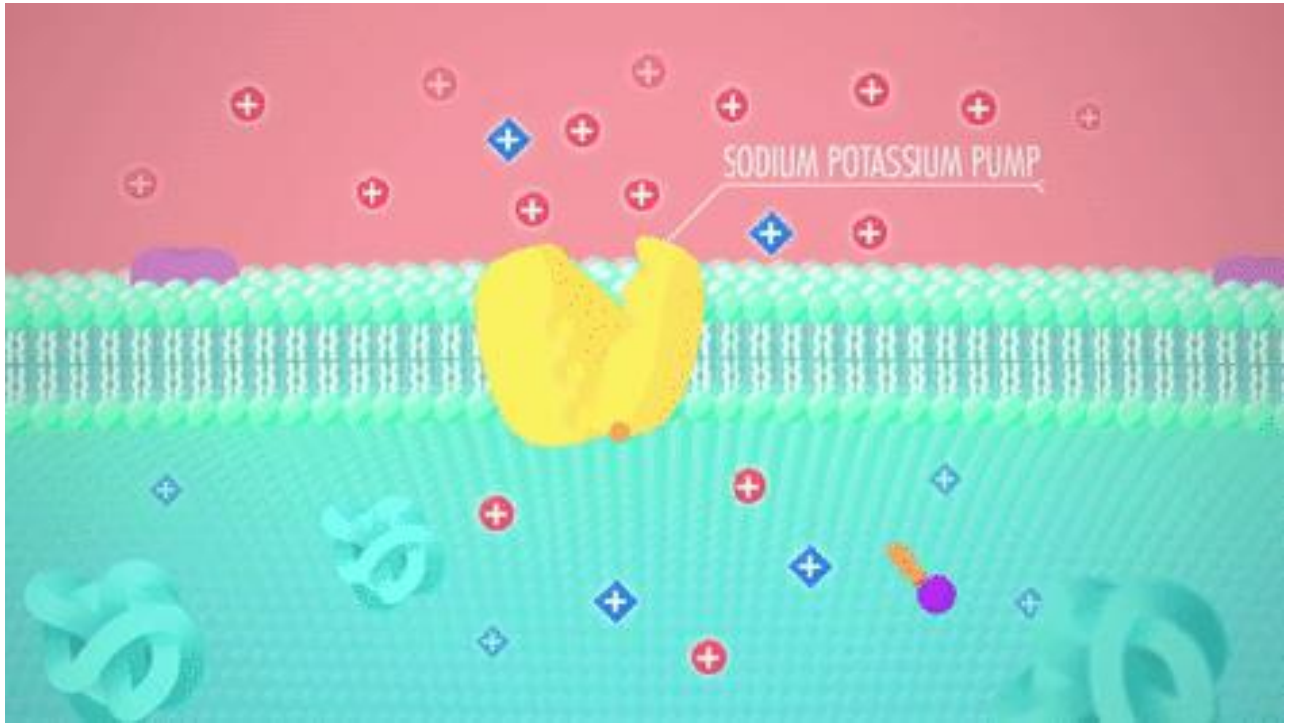
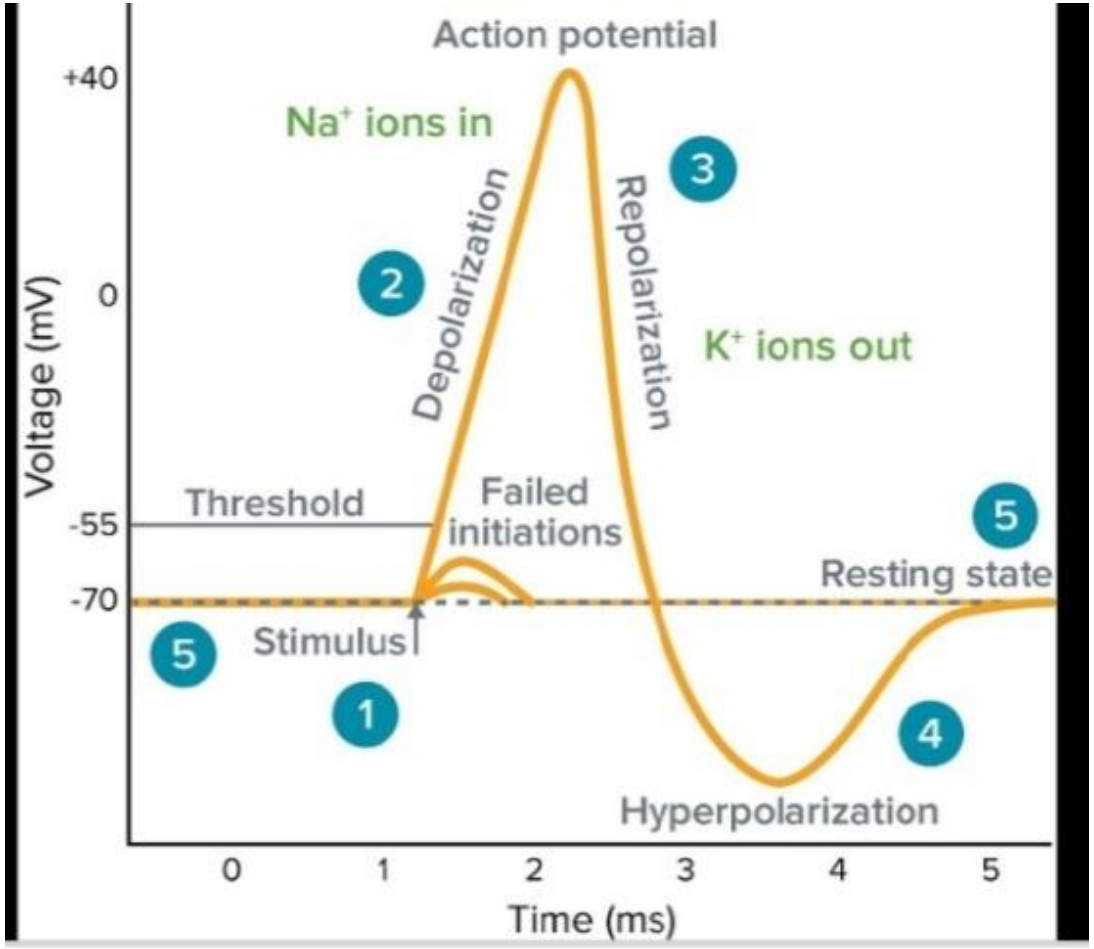


Sodium potassium pump maintains an electrochemical gradient inside neurons

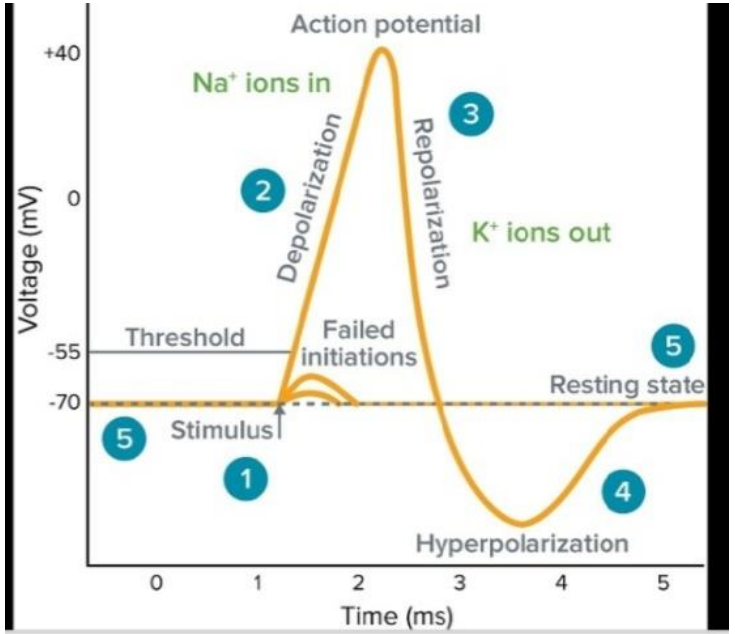
What is Action Potential?

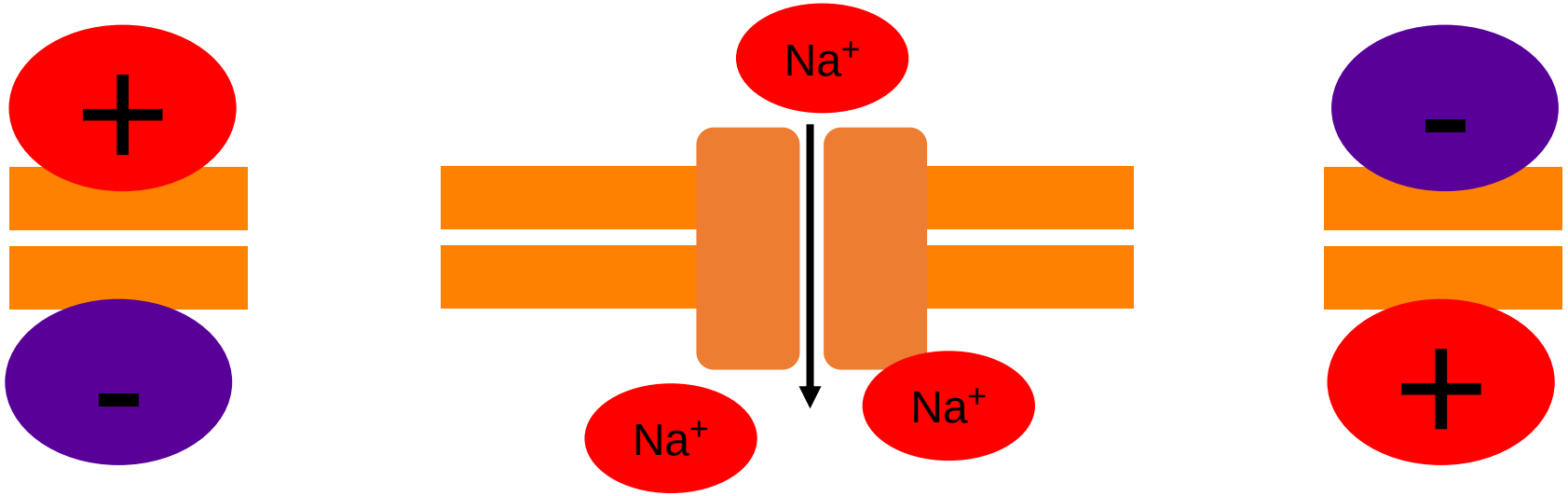
- An action potential is a predictable change in membrane potential that occurs due to the open and closing of voltage gated ion channels on the cell membrane.



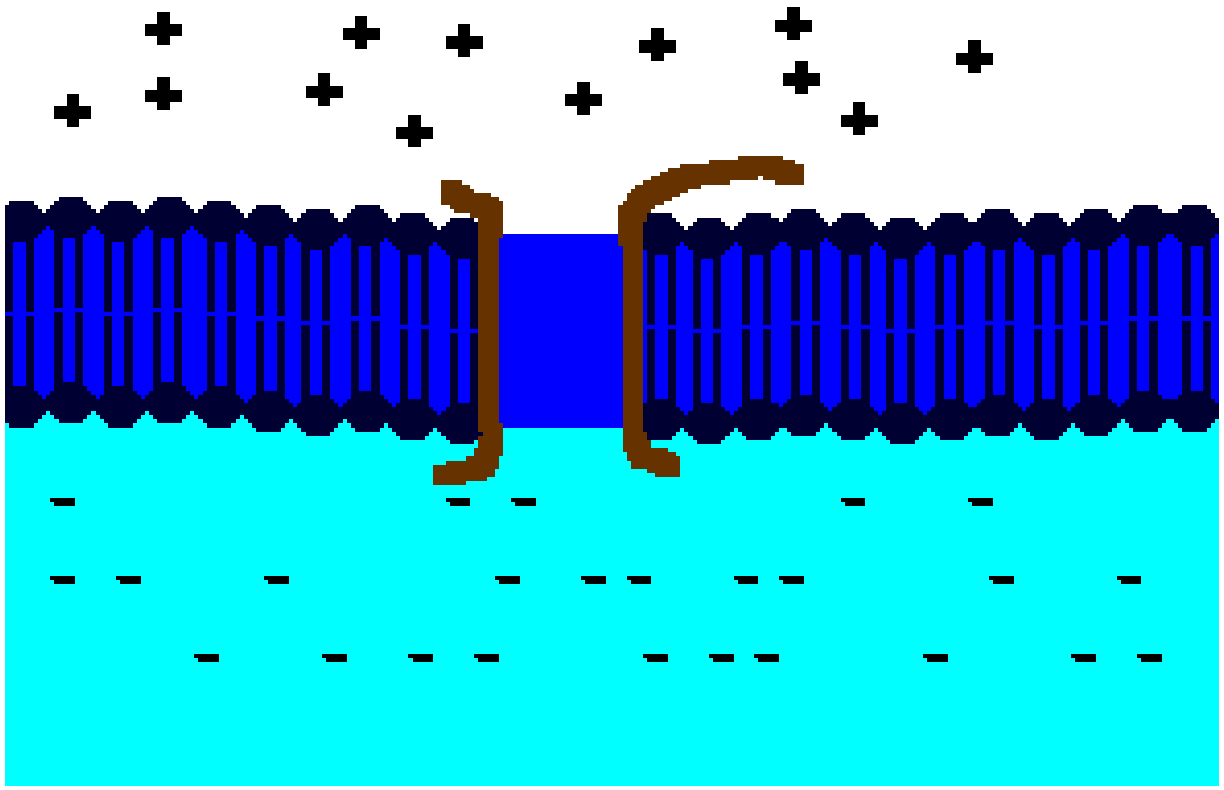
Action potentials: Rapid depolarization

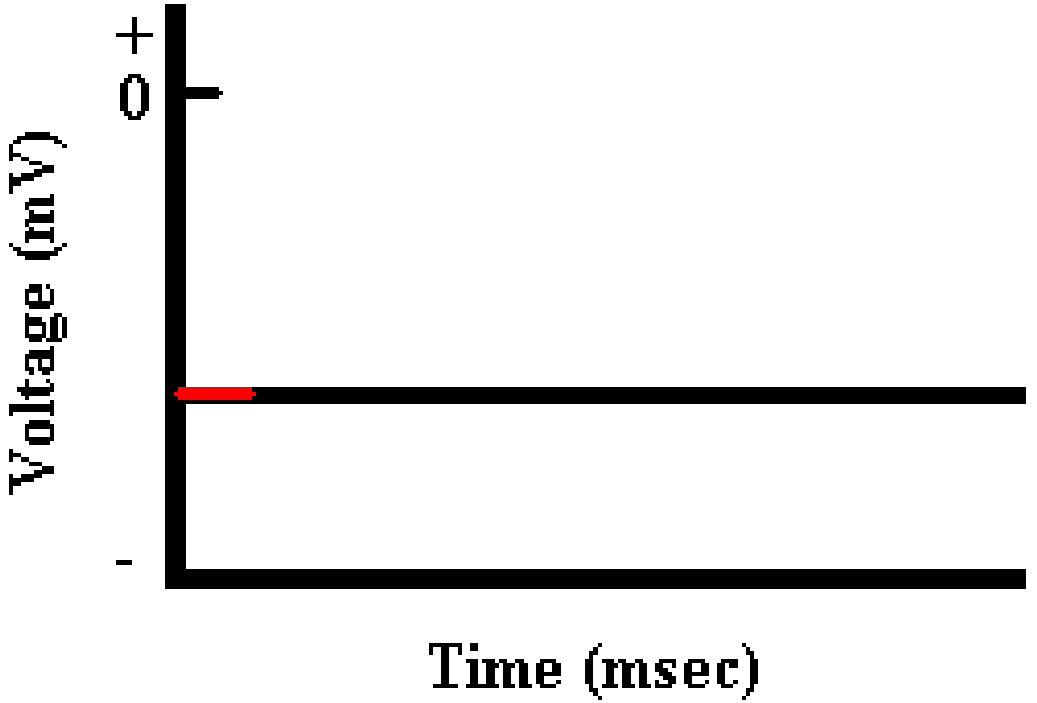
- When partial depolarization reaches the **activation threshold, voltage-gated sodium ion channels** open.
- Sodium ions rush in.
- The membrane potential changes from -70mV to +40mV (2).





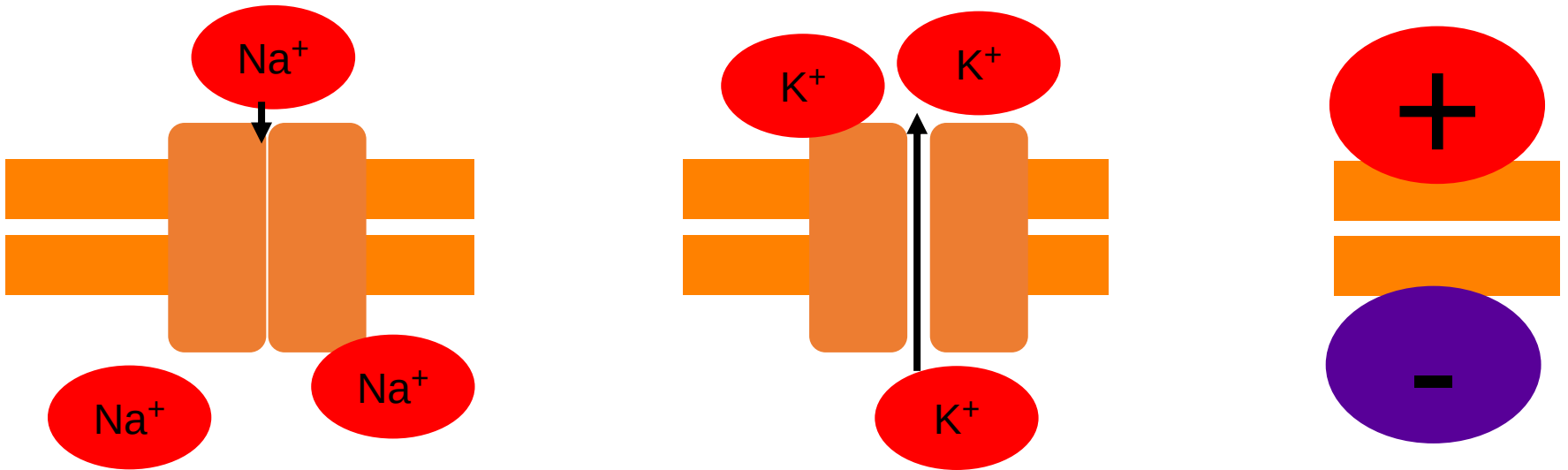
Depolarization



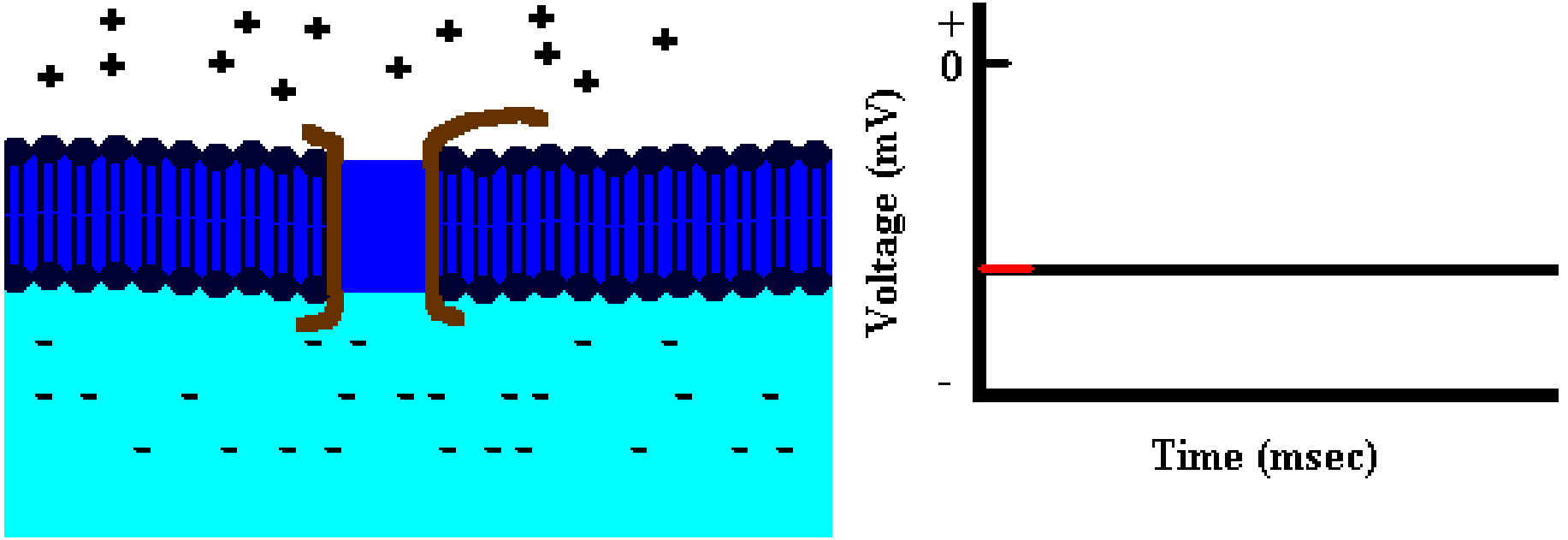


Action potentials: Repolarization

- 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.

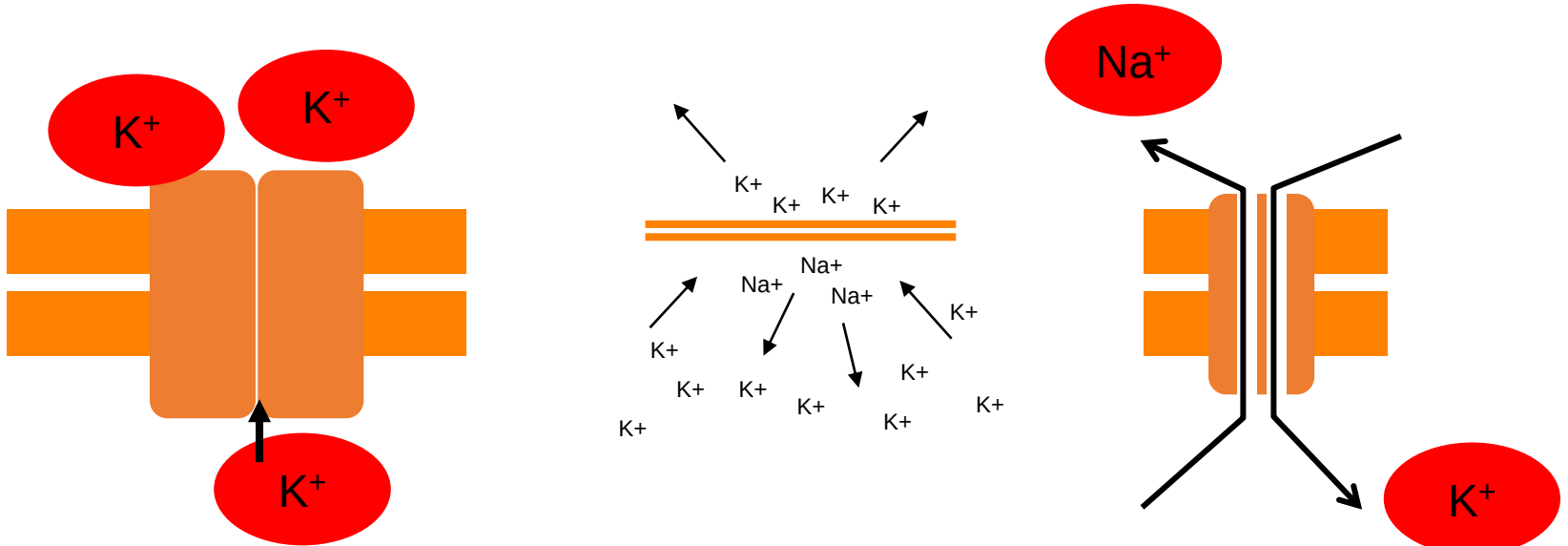


Repolarization



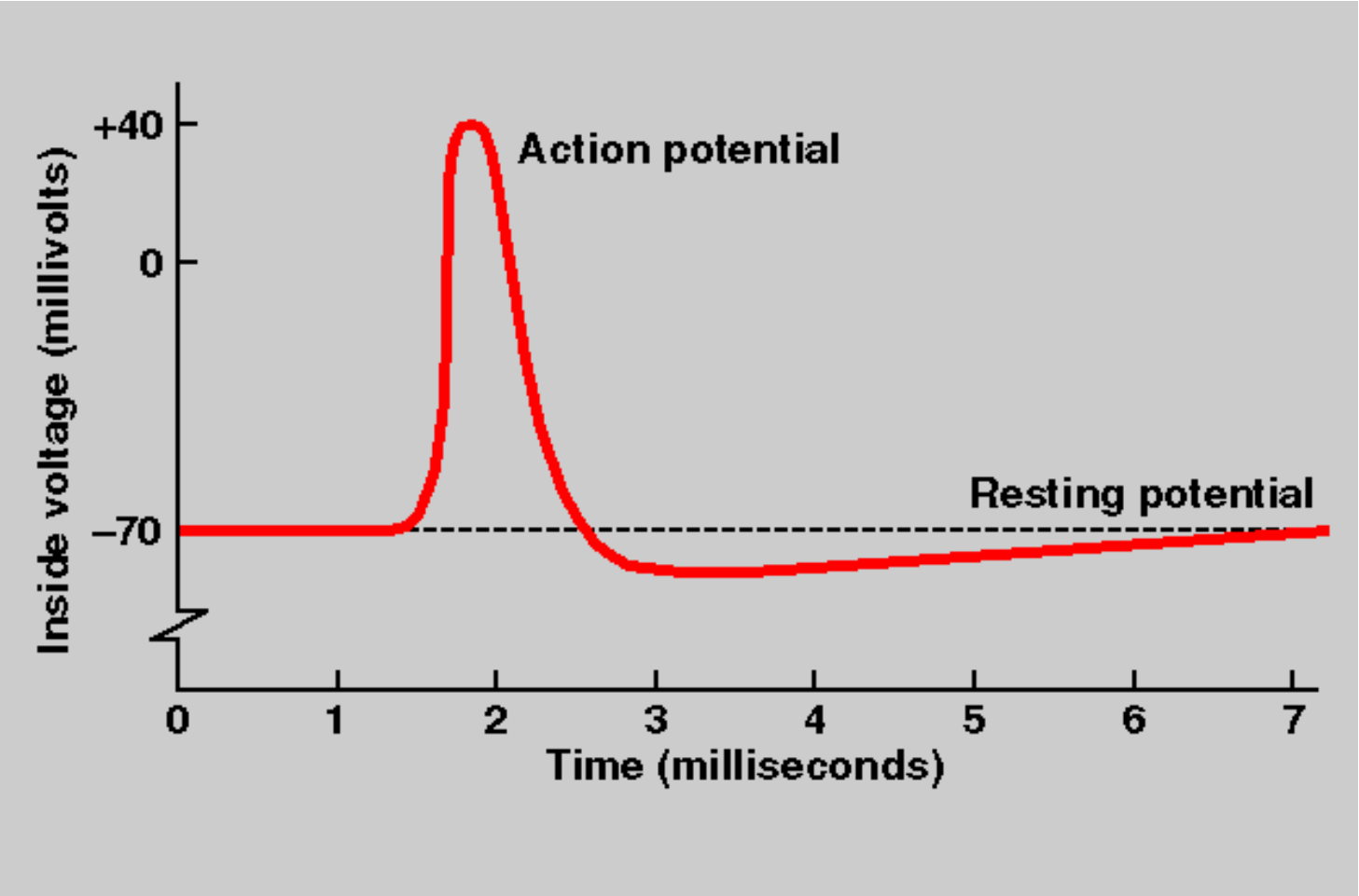
Action potentials: Resuming the Resting Potential

- Potassium channels close.
- Repolarization resets sodium ion channels.
- Ions diffuse away from the area.
- Sodium-potassium transporter maintains polarization.
- The membrane is now ready to “fire” again.

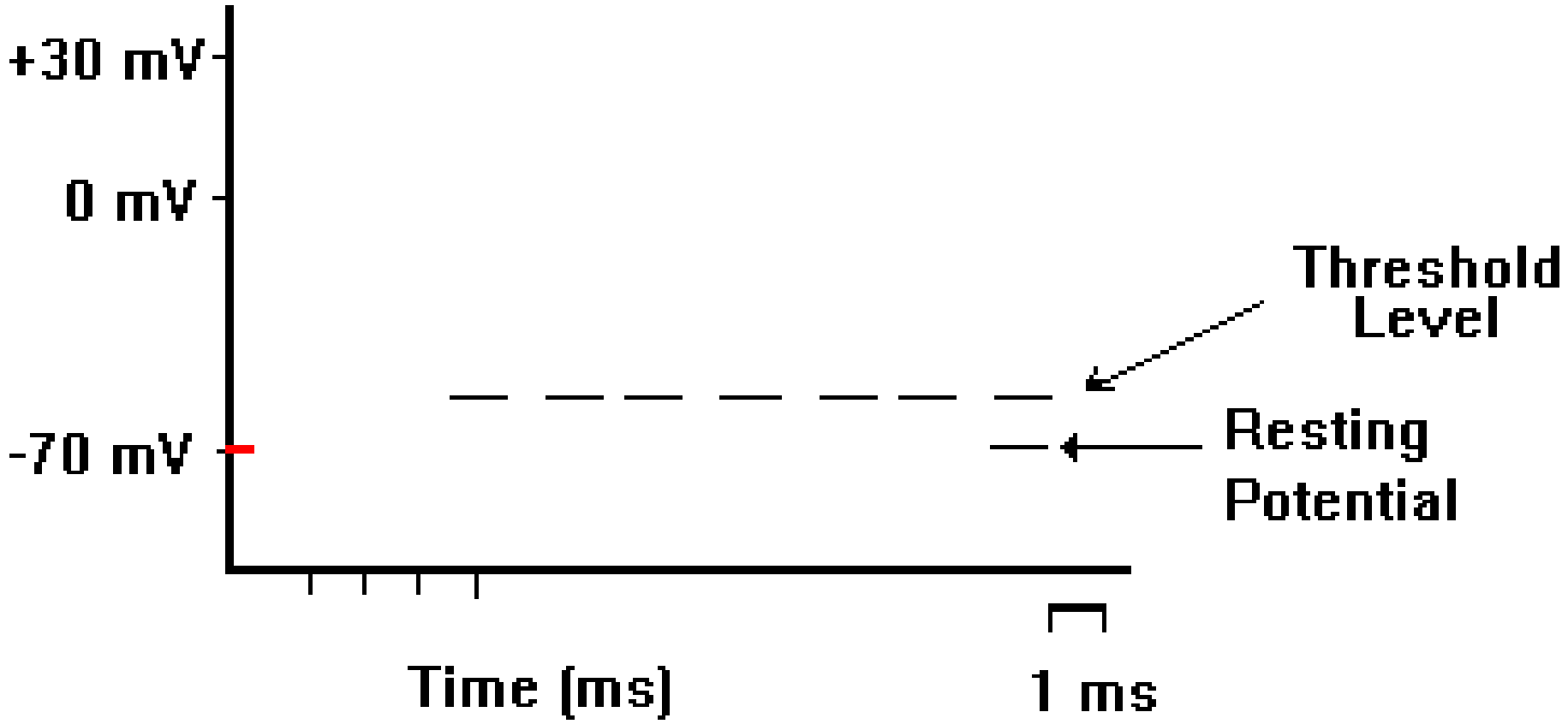


Action potential

Action Potential = ALL x NOTHING

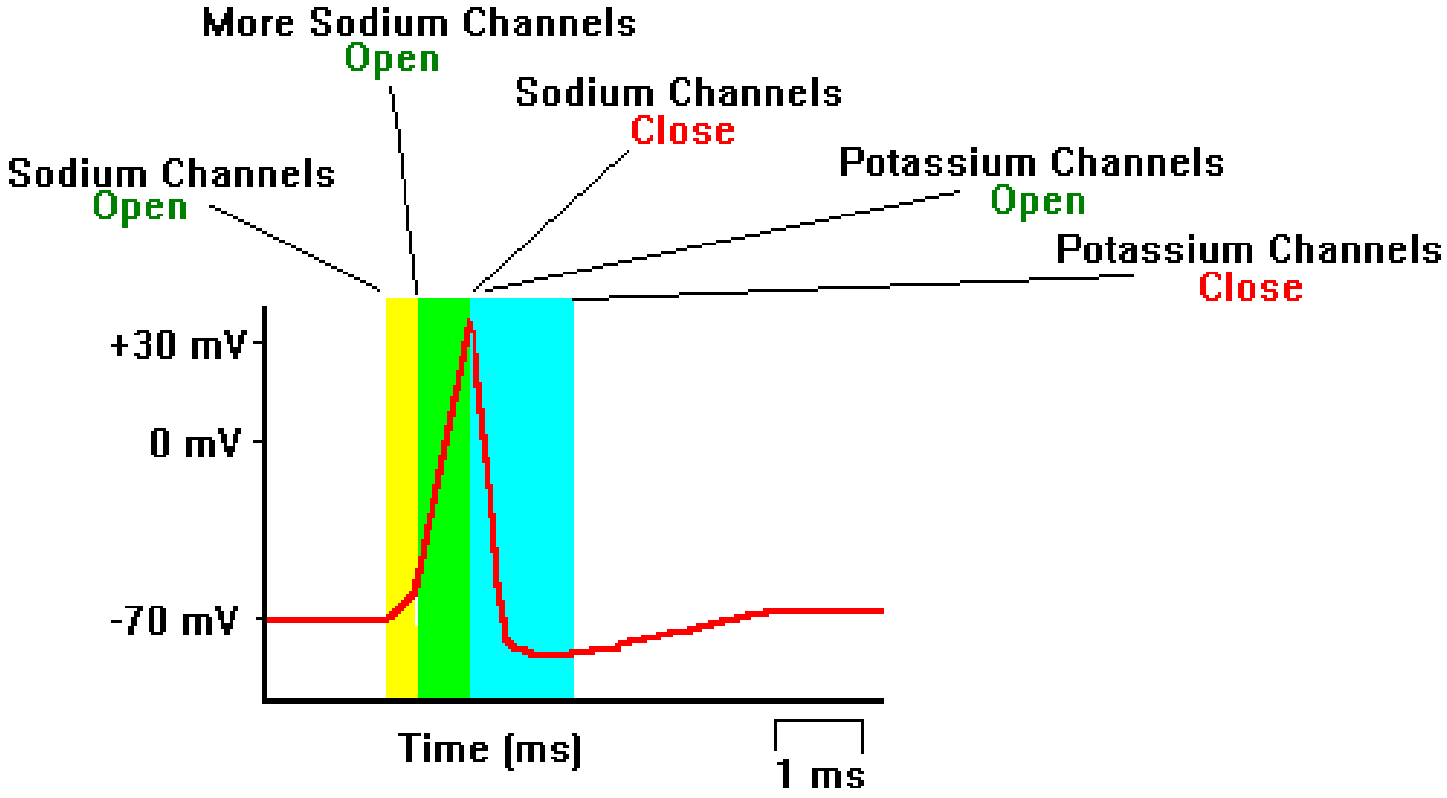


Action potential

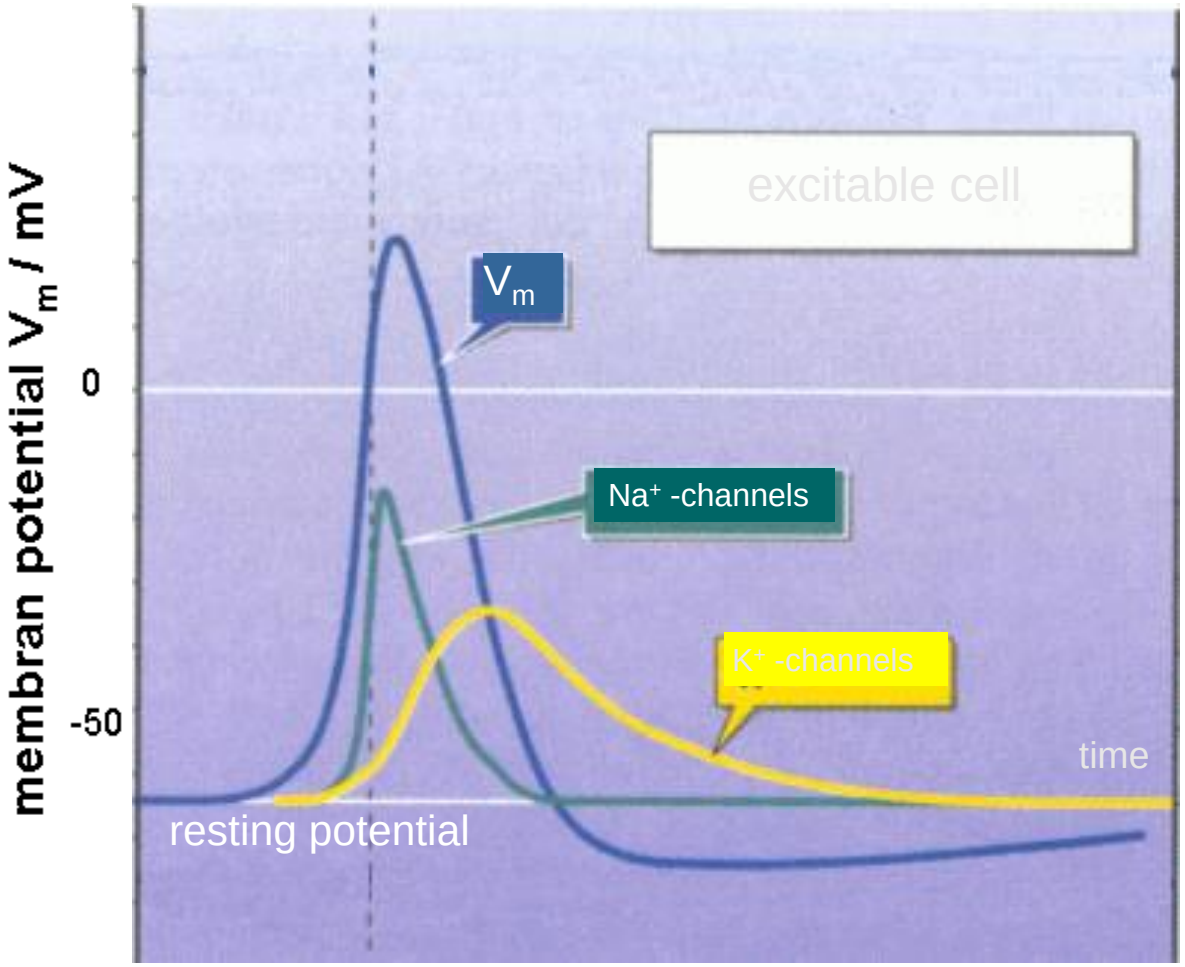


Action potential

Action Potential = opening of sodium and potassium channels



Action potential



Ionic Mechanisms of Action Potentials