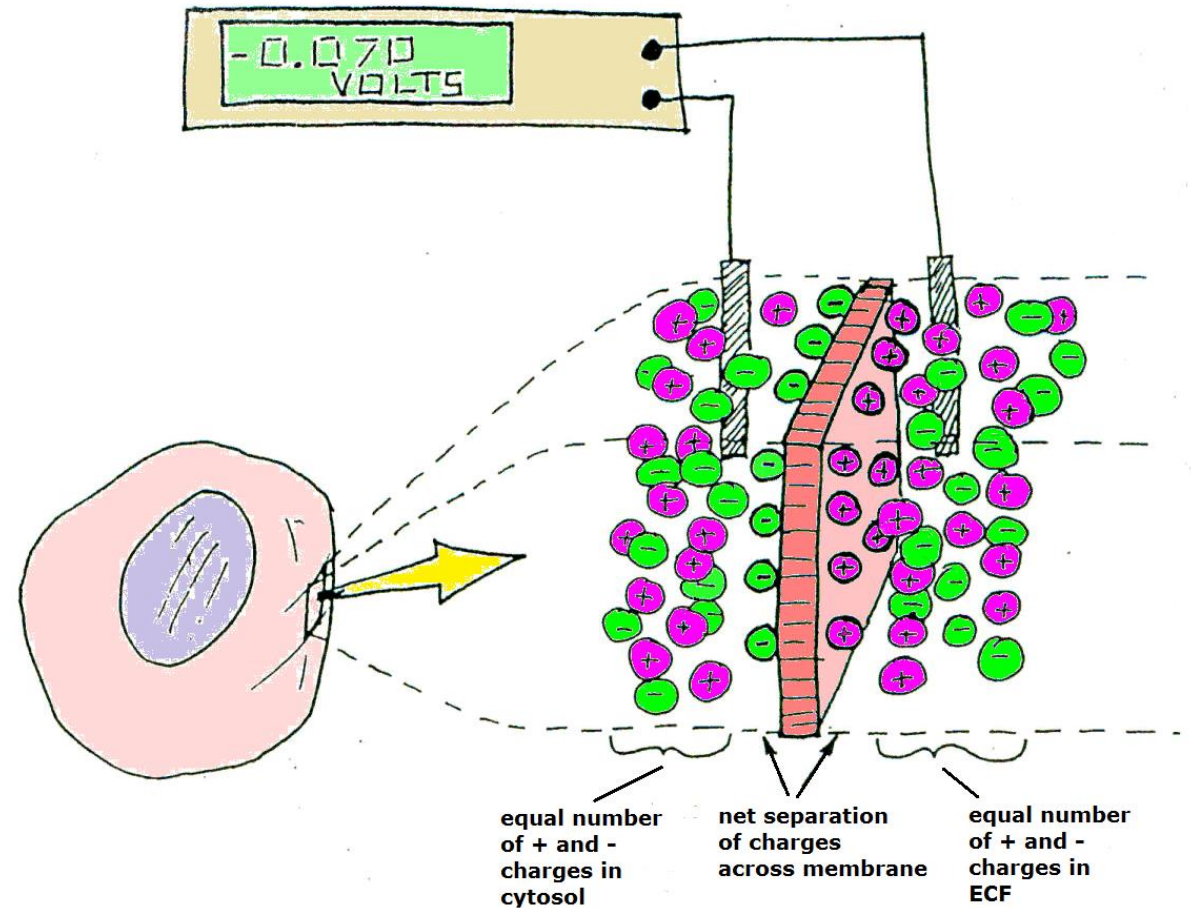


Membrane Potential, Action Potential and Ion Channels

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Membrane potential

- In all type of cells, there is an **electrical potential difference** between the inside of the cell and the surrounding extracellular fluid. This is termed the **membrane potential** of the cell.
- Two energetic factors influence the movement of an **ion** across a membrane.
- The concentration gradient
- The electrical potential difference



Membrane potential

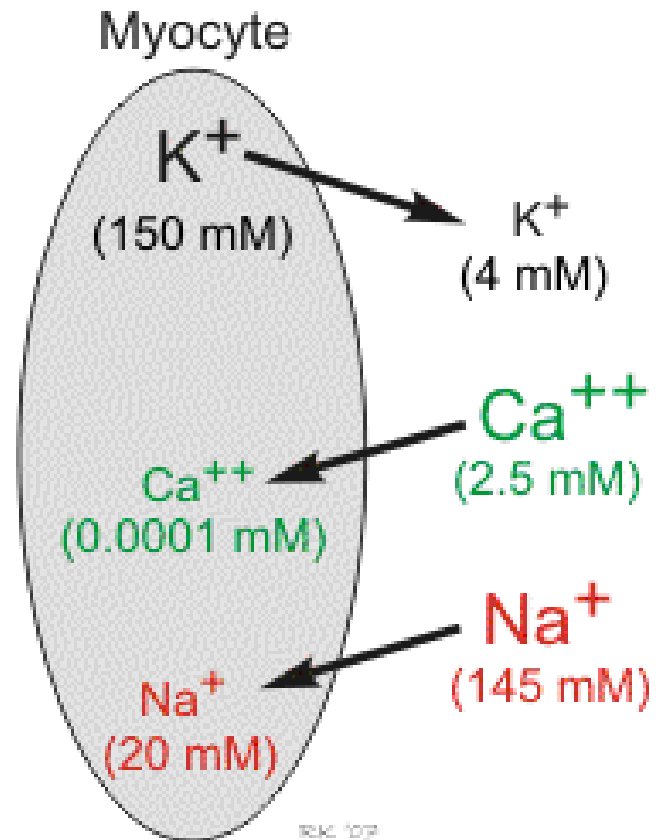
Membrane potentials in cells are determined primarily by three factors:

- 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.

Membrane potential

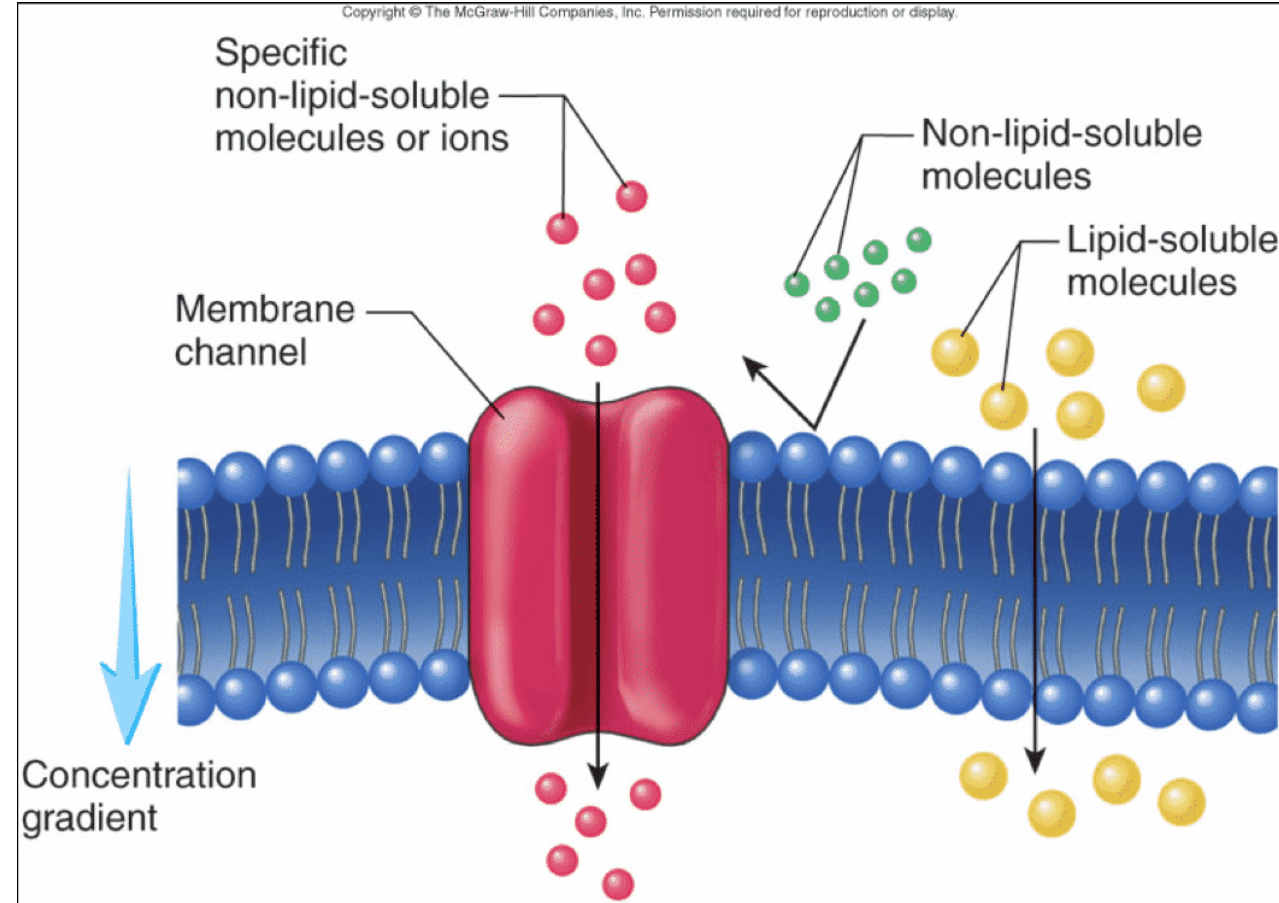
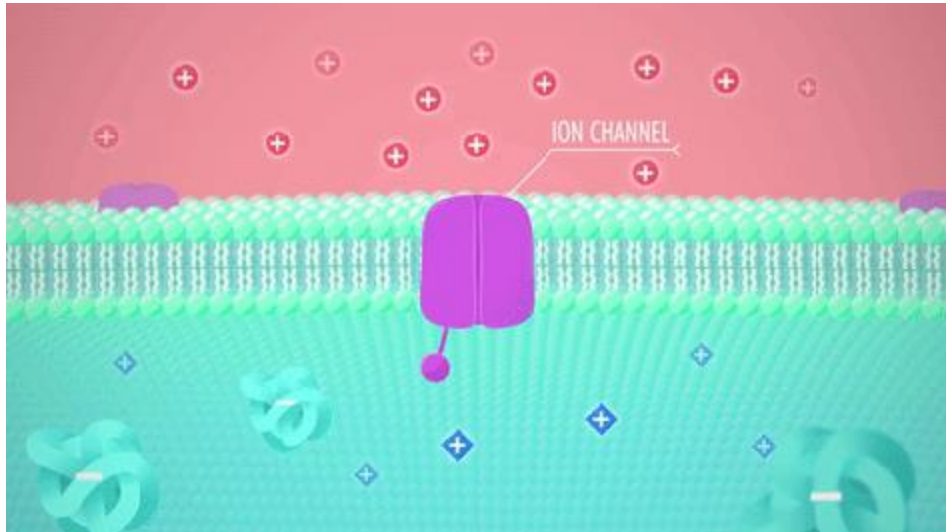
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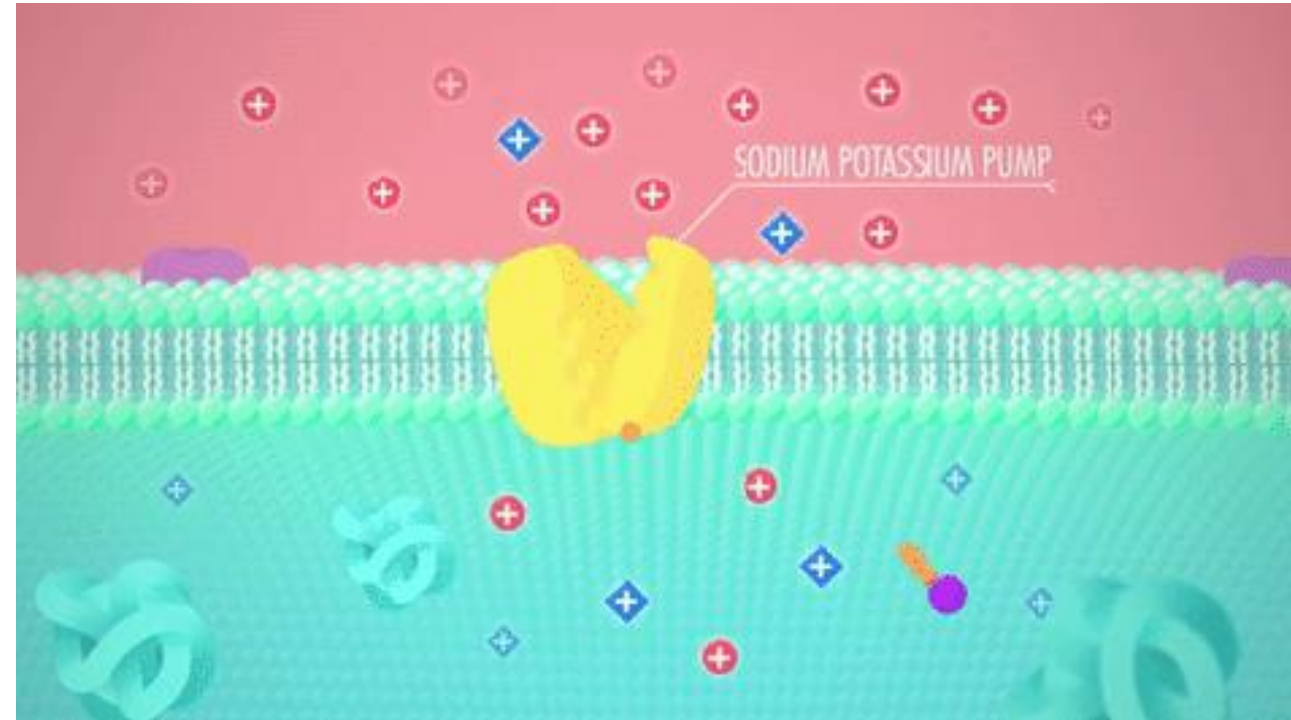
Membrane potential

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Membrane potential

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



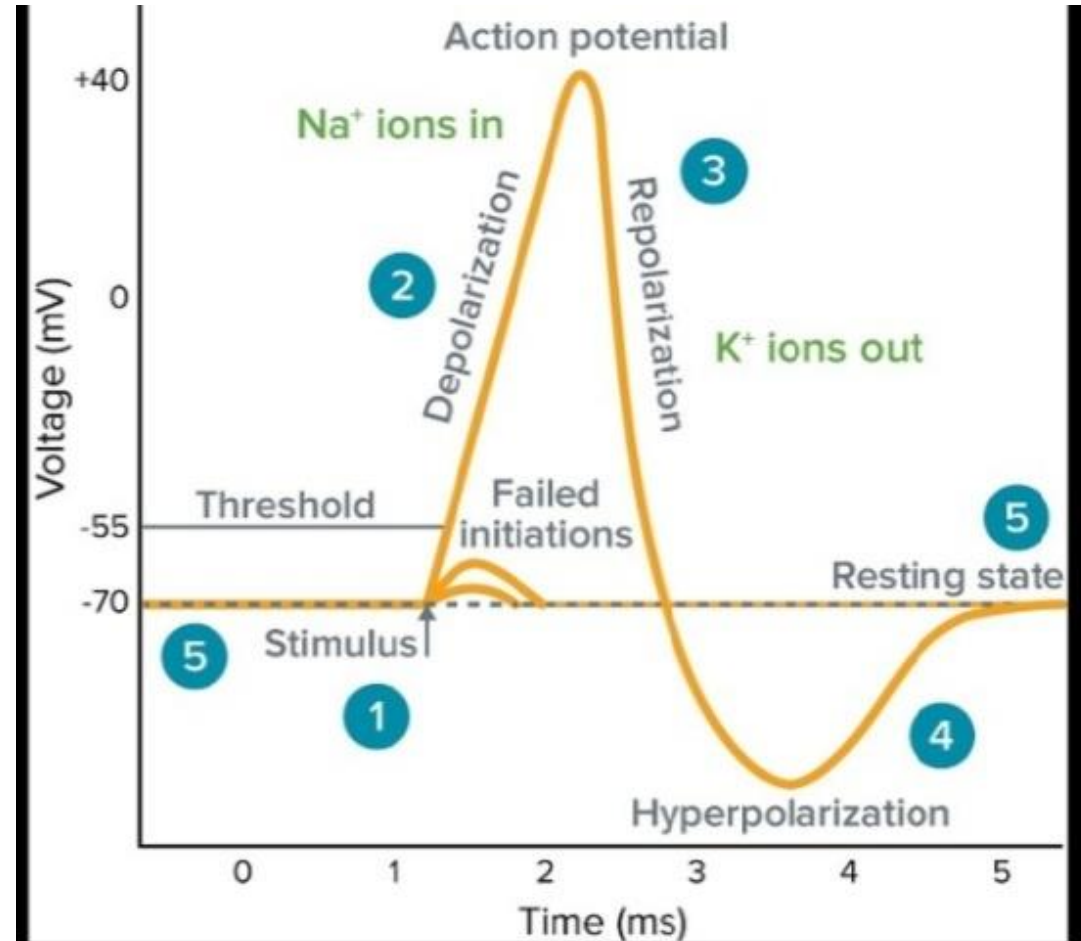
Sodium potassium pump maintains an electrochemical gradient inside neurons

What is an excitable cell?

- Excitable cells are those capable of developing action potentials across their plasma membranes. They can do this because they express voltage-gated cation channels in specific membrane domains. Muscle is considered a type of “excitable cell” and the majority of muscle types will produce action potentials along their plasma membranes (or sarcolemma).

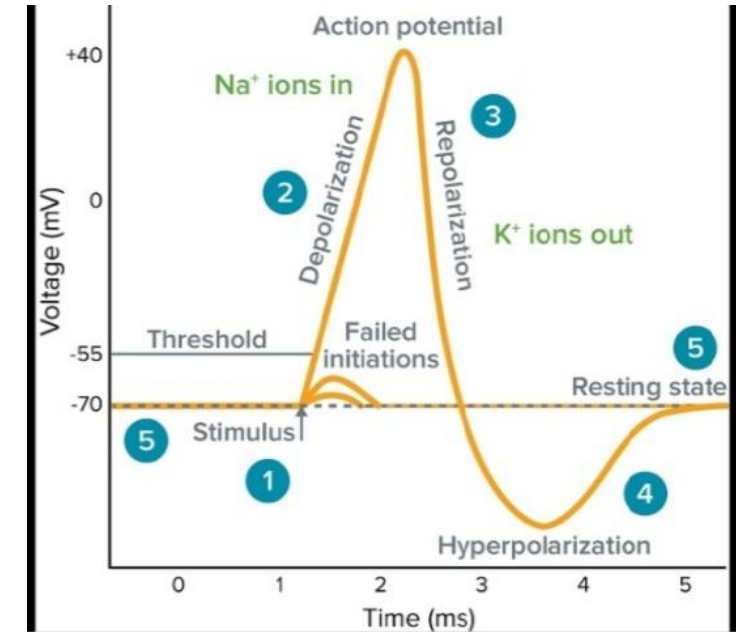
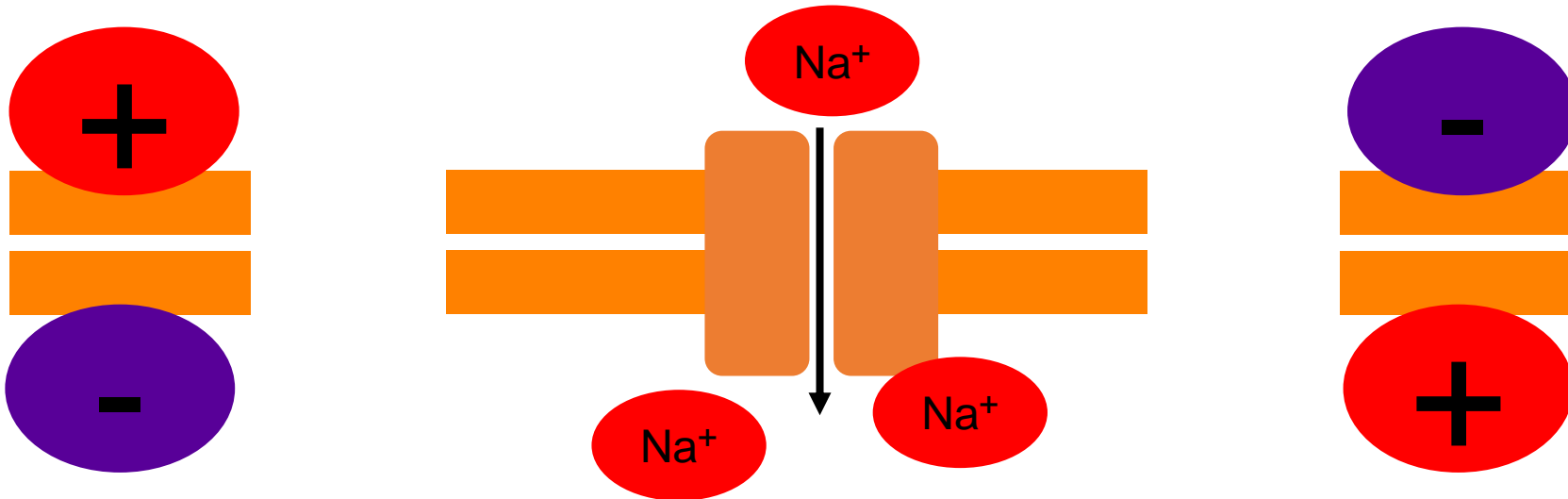
What is Action Potential?

- 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.

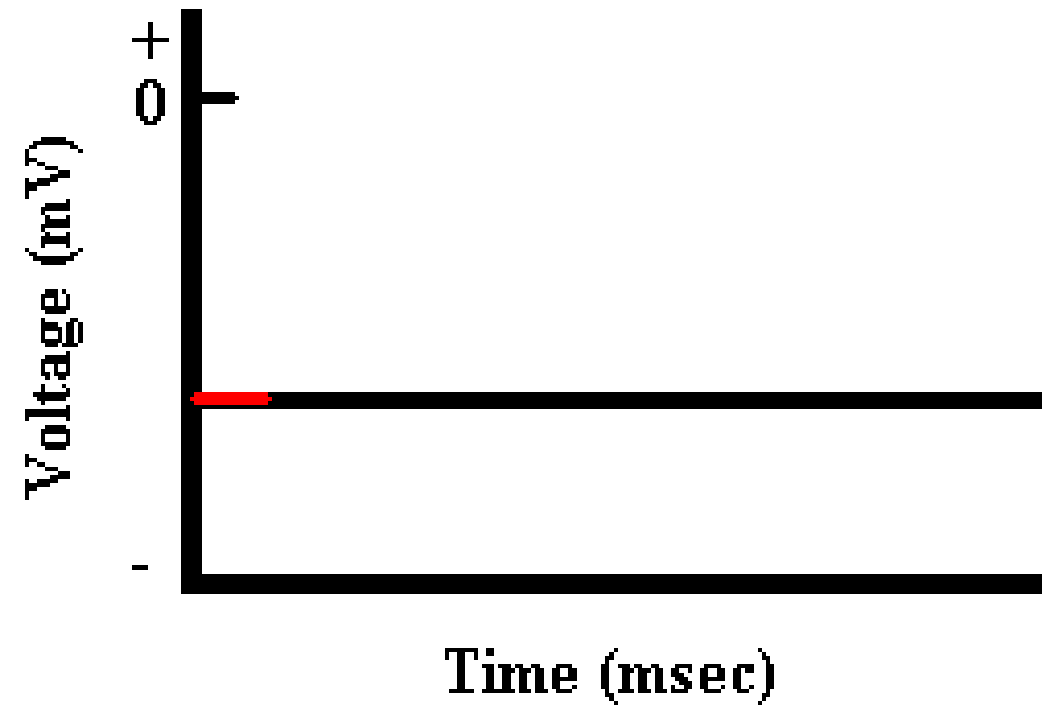
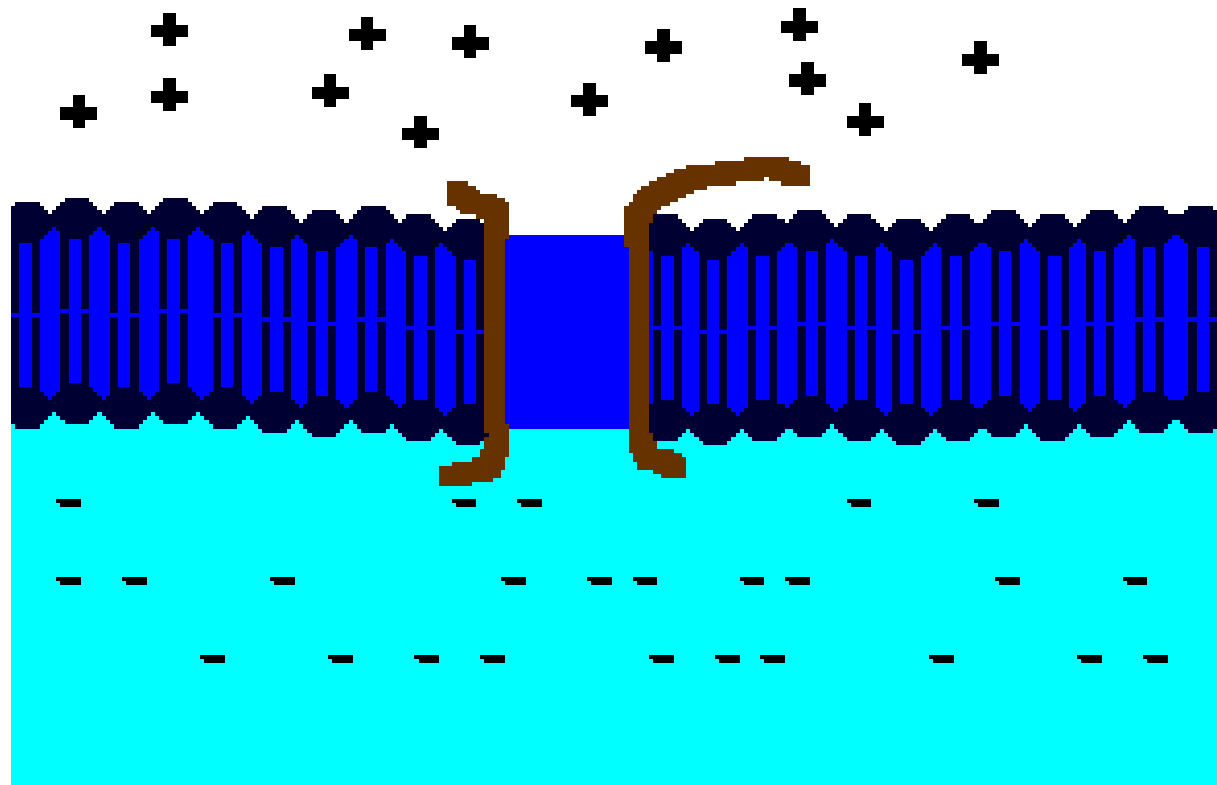


Action potentials: Rapid depolarization

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

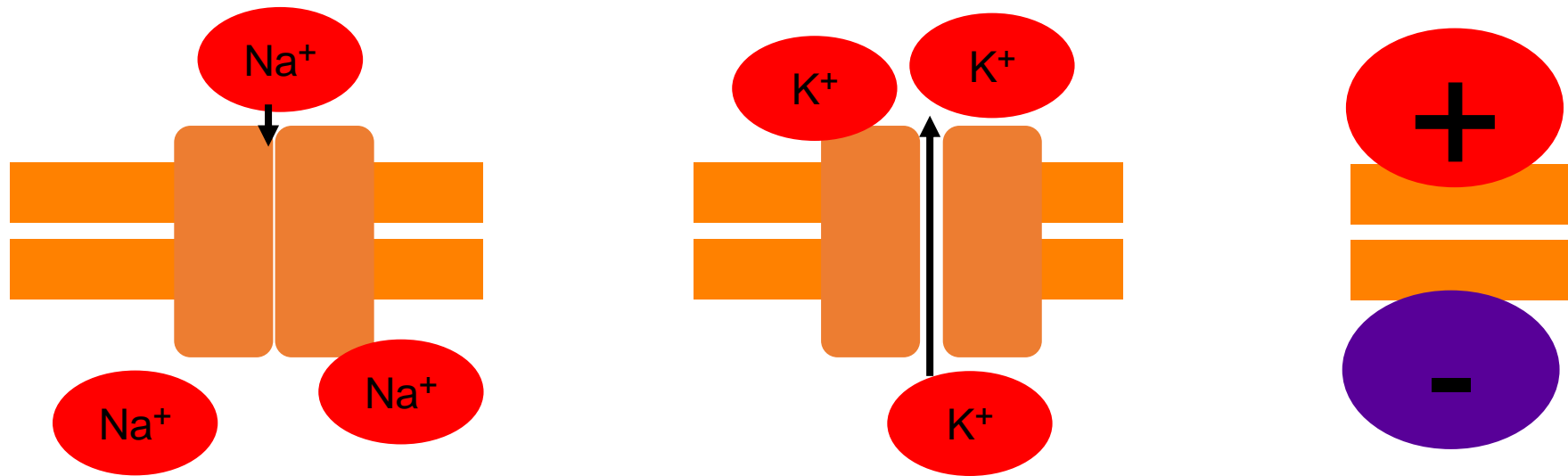


Depolarization

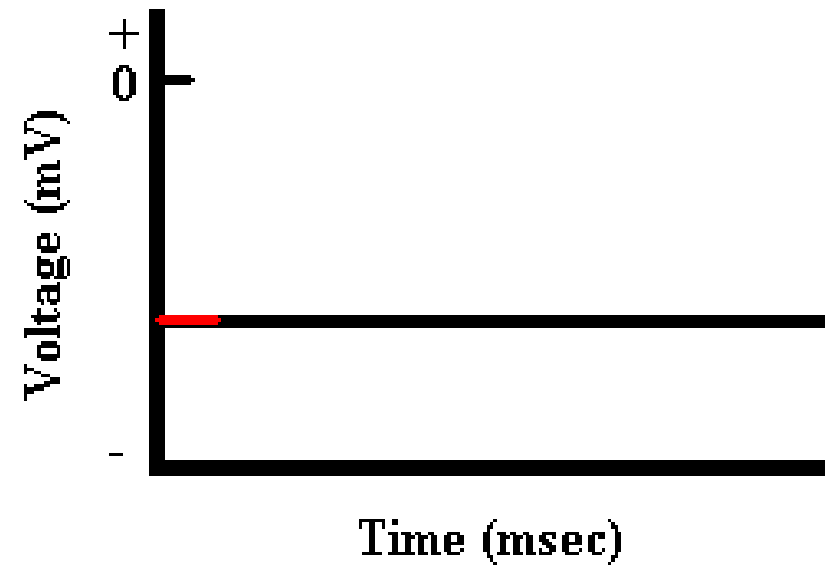
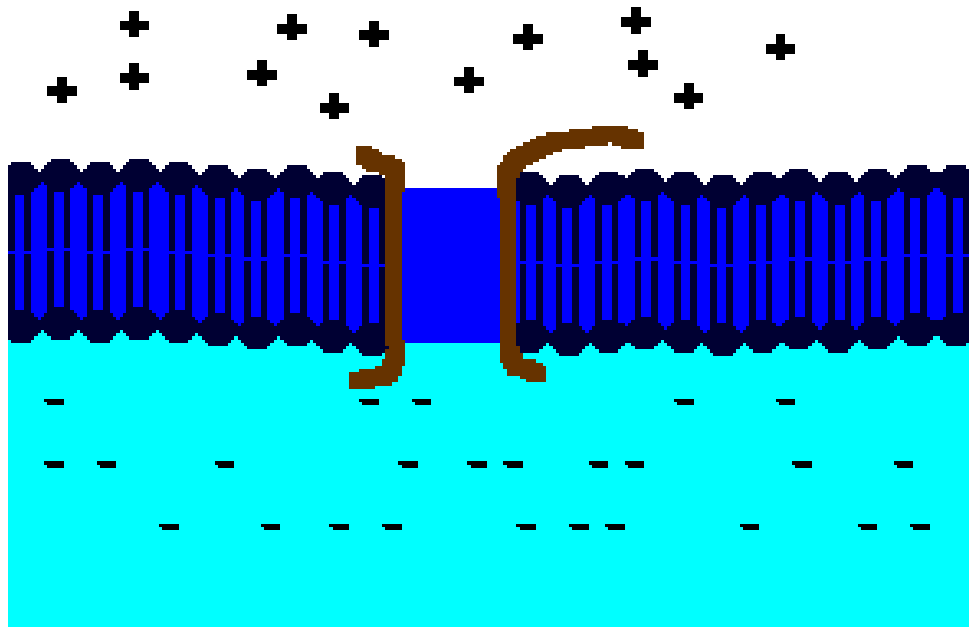


Action potentials: Repolarization

- 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.

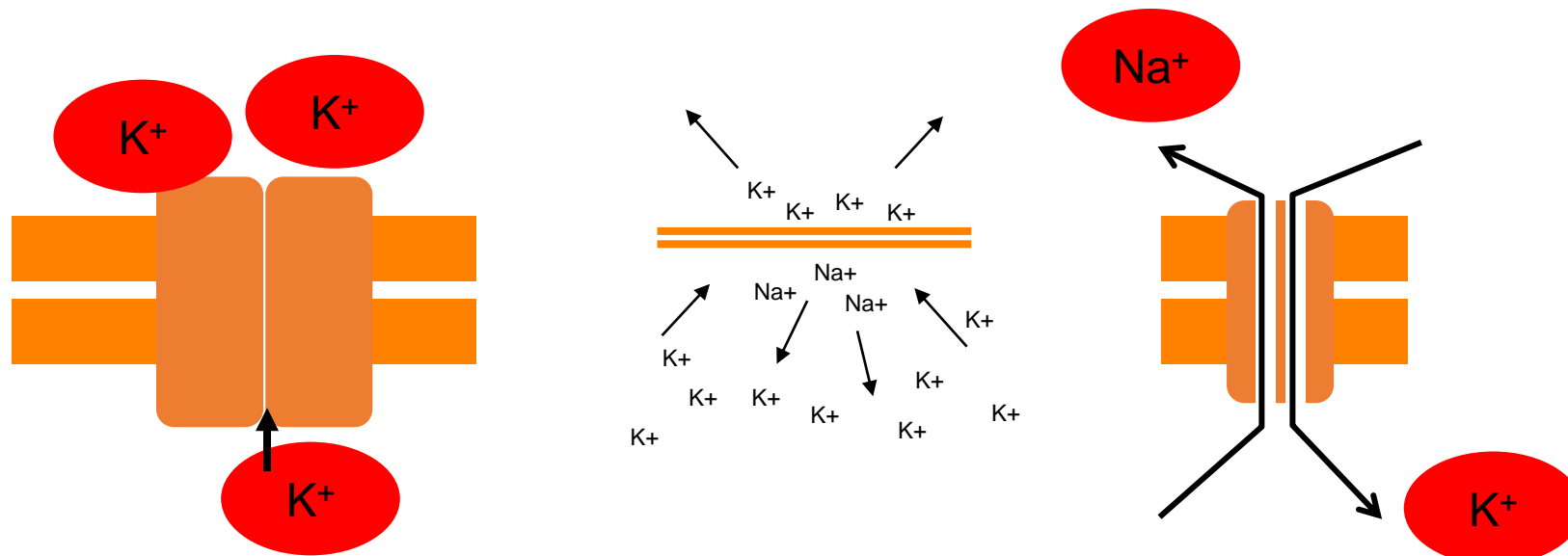


Repolarization



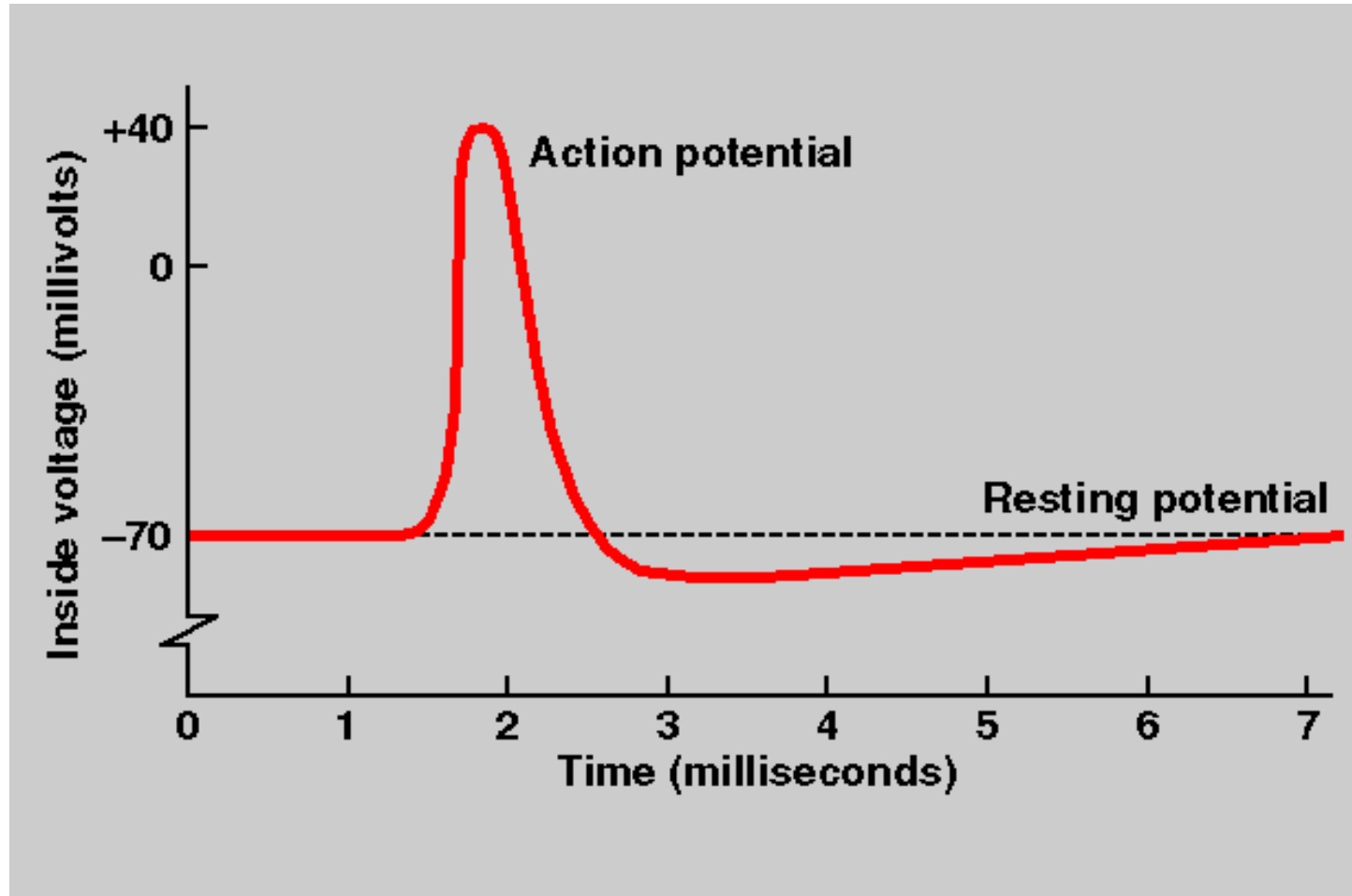
Action potentials: Resuming the Resting Potential

- 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.

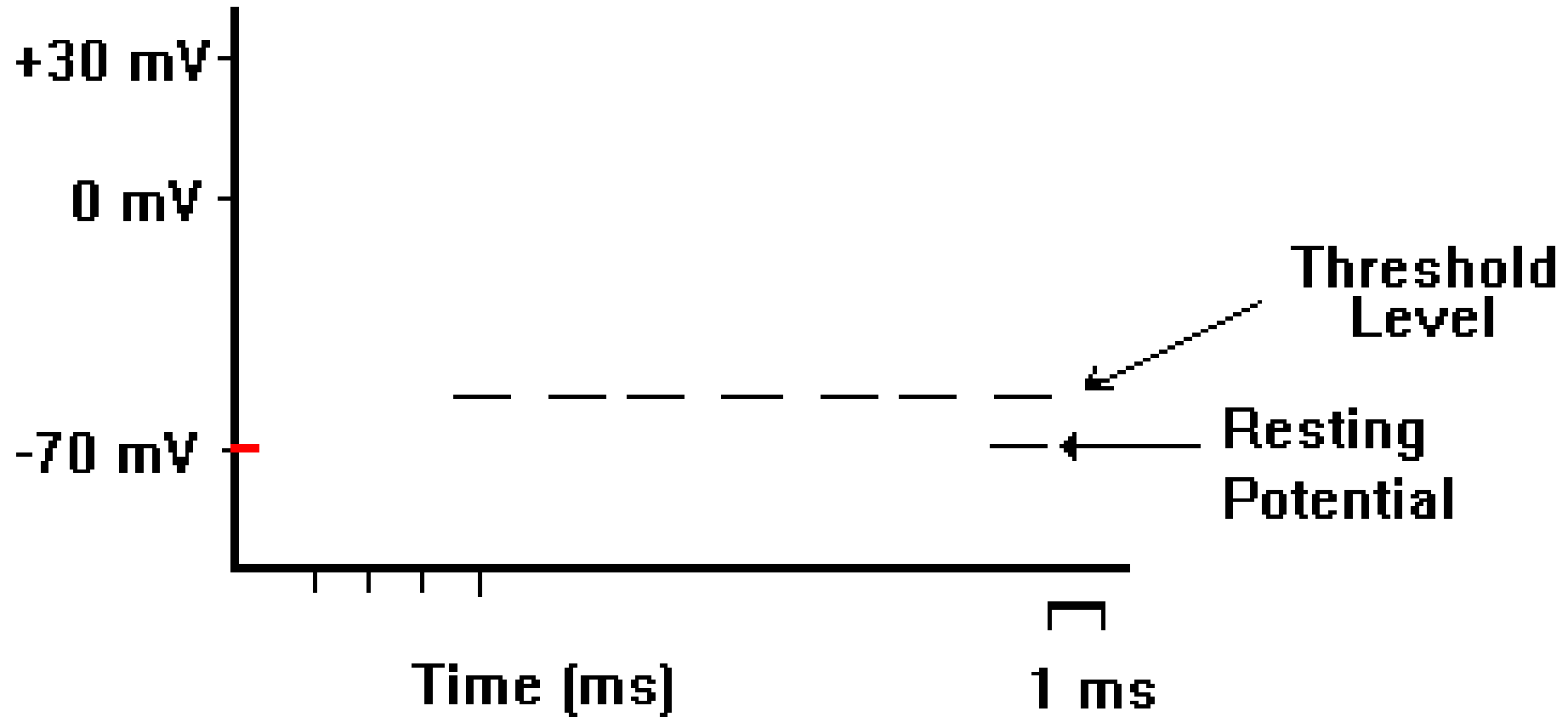


Action potential

Action Potential = ALL x NOTHING

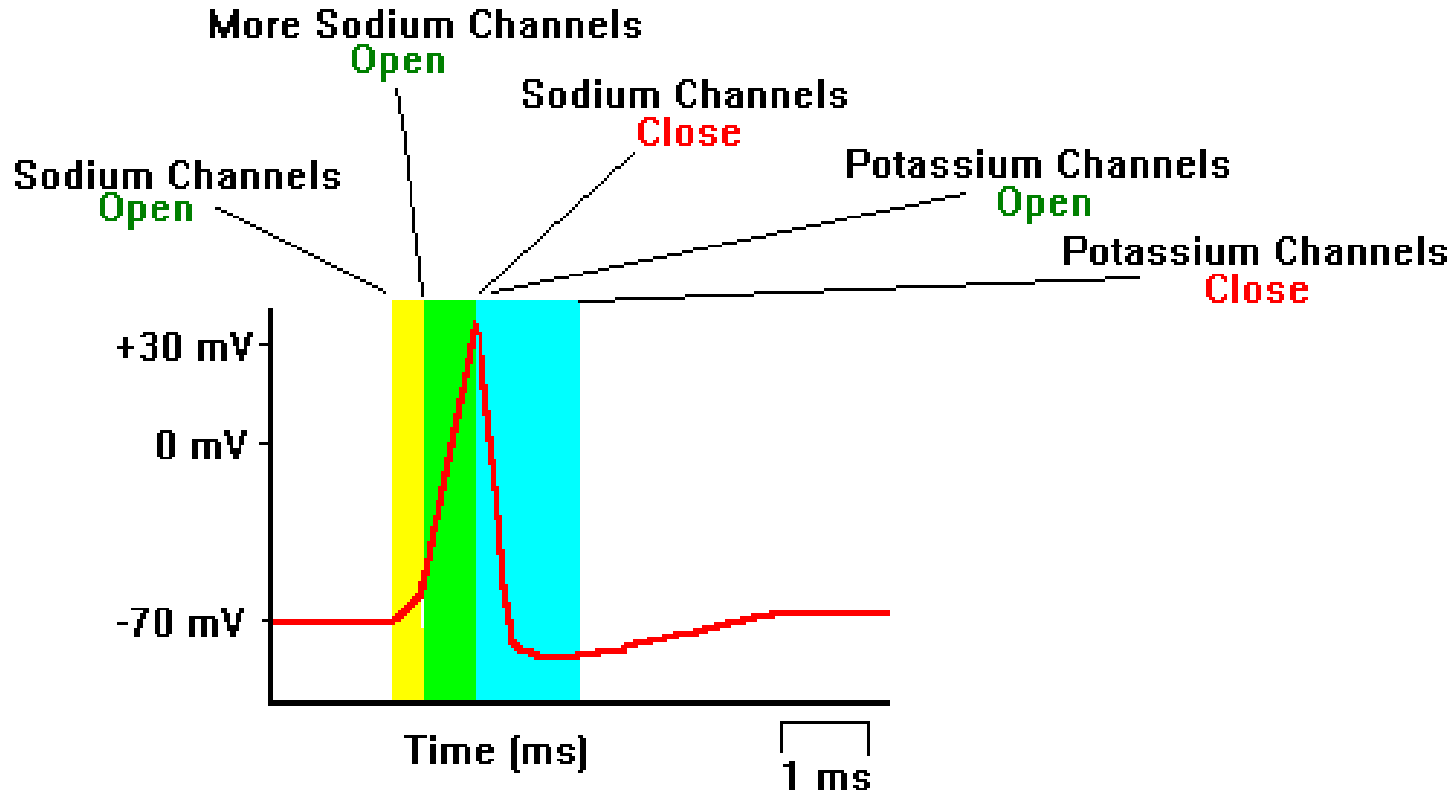


Action potential

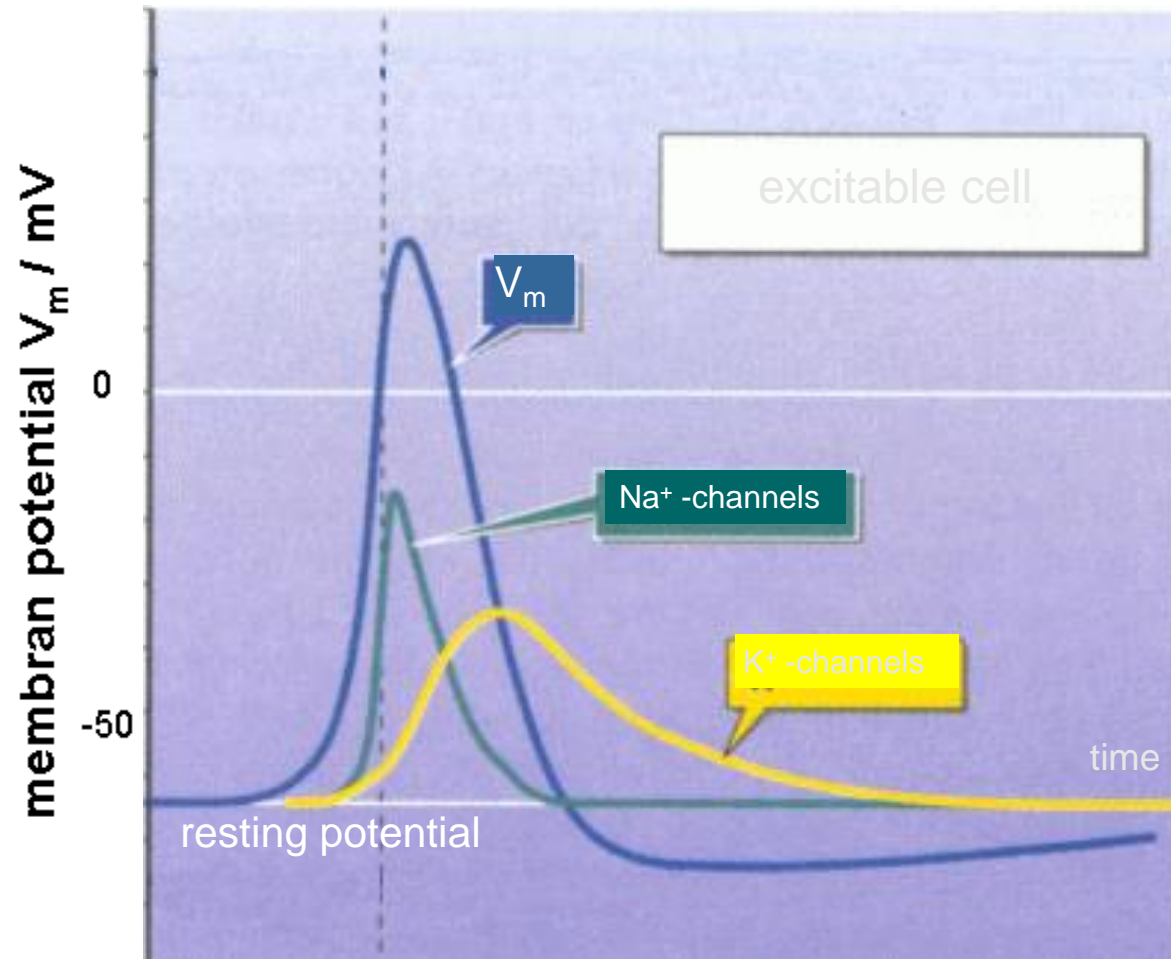


Action potential

Action Potential = opening of sodium and potassium channels



Action potential



Ionic Mechanisms of Action Potentials

