2026-09-27 Lectures on general topic of Action Potentials (8 lectures) by Wendy Riggs, Youtube.com clarified & expanded by Gemini AI

https://gemini.google.com/app/8e5a5f56ede591dc

To: Gemini, Subject, Wendy Riggs Lectures on Action potentials in biology, covering on youtube.com the following: 1]NS cells, 2]Neuron 3]electricity 4] NA+ K+ Pump 5]resting membrane potential 6]The Action Potential 7] Steps 8] Refractory periods. End list//
For this inquiry with Gemini discuss the following ask requested:
Ref: Action Potential Lectures by Wendy Riggs, Lecture 4, The Sodium Potassium Pump.
‘’’https://www.youtube.com/results?search_query=Action+Potential+Lectures+by+Wendy+Riggs%2C+Lecture+4’’’ //Please explain clearly at 9th grade Highschool level, USA, about concentration gradients in the context of the sentence that follows by biologist Wendy Riggs. How the gradient developes, i.e., established – what leads up to the createion of this chemical (I assume) gradient where the concentration of the ions changes its concentration (density) etc.//
//Wendy Riggs states the following at start of this lecture:
The sodium potassium pump is going to pump ions, sodium ions and potassium ions against their concentration gradients and help establish a difference in the charges of the intracellular fluid and the extracellular fluid.// If at the end you can give one or more youtube or article which will show in graphic detail this concentration that will be appreciated.//Nenad

What is a Concentration Gradient?

In biology and chemistry, **concentration** simply means how crowded particles are in a given space (their density).

A **concentration gradient** exists whenever there is a difference in particle crowd levels between two areas—like the inside of a cell (**intracellular fluid**) versus the outside (**extracellular fluid**).

- **The Natural Flow (Diffusion):** Particles naturally bump into each other and spread out from an area of *high concentration* (crowded) to an area of *low concentration* (less crowded). Think of a drop of food coloring spreading in a glass of water, or spraying perfume in the corner of a classroom until the whole room smells like it. This "downhill" movement happens on its own without energy.
- **Against the Gradient:** Moving particles "against their concentration gradient" means forcing them from an area where they are scarce into an area where they are already heavily packed together. This is like trying to shove more people into an already crammed subway car—it requires active physical work and energy.
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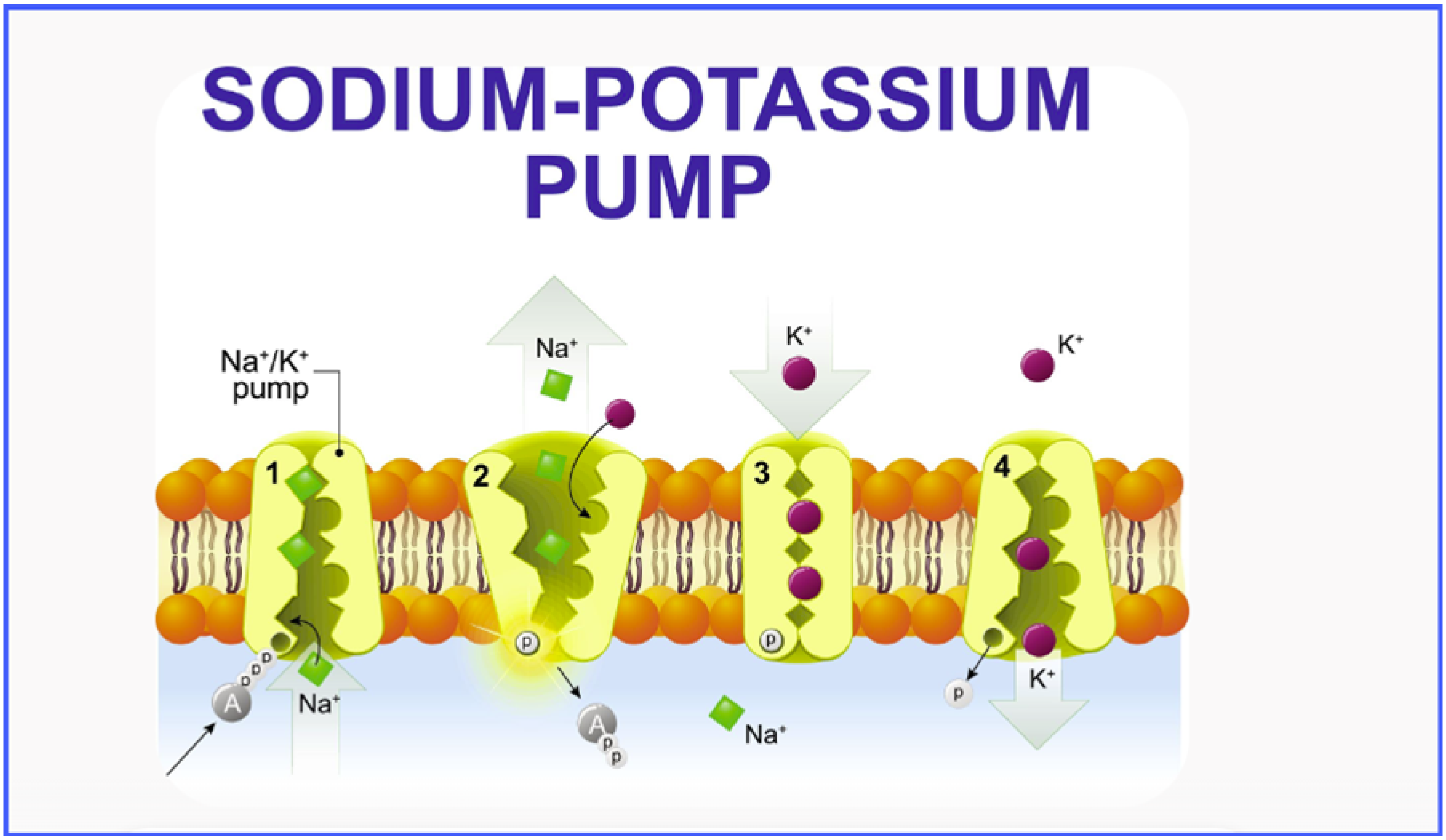
Wendy Riggs' Statement & How the Gradient is Built

In Action Potential 4- Sodium potassium pump, Wendy Riggs explains:

"The sodium potassium pump is going to pump ions, sodium ions and potassium ions against their concentration gradients and help establish a difference in the charges of the intracellular fluid and the extracellular fluid."



Sodium Potassium Potential Graphic by Gemini AI

Step-by-Step: How the Chemical and Electrical Gradients Develop
Left to natural diffusion, sodium (Na^+) and potassium (K^+) would spread out until they were evenly balanced on both sides of the cell membrane. The cell uses the **Na^+/K^+ ATPase pump** (a specialized protein embedded in the membrane) to intentionally disrupt that balance:

1. **Sodium Binds from the Inside:** Inside the cell, 3 sodium ions (Na^+) bind to specific pockets inside the pump protein.

2. **Energy (ATP) Powers the Pump:** A molecule of **ATP** (the cell's rechargeable battery) transfers a phosphate group to the pump. This surge of energy forces the pump protein to shift its physical shape.

3. **Sodium is Expelled Outside:** The pump opens to the extracellular fluid, changing the shape of the binding sites so the 3 Na^+ ions detach into the outside fluid.

4. **Potassium Binds from the Outside:** While open outward, 2 potassium ions (K^+) from the outside fluid bind into new receptor slots on the pump.

5. **Resetting Inward:** The phosphate drops off, causing the pump to snap back to its starting orientation, releasing the 2 K^+ ions inside the cell.

The Two Gradients Created:

- **Chemical Concentration Gradient:**
    - **Outside:** Packed with high concentrations of sodium (Na+) .
    - **Inside:** Packed with high concentrations of potassium (K+).
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    -
- **Electrical Gradient (Charge Difference):**
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Because the pump kicks out **3 positive charges** for every **2 positive charges** brought in, the inside of the cell loses net positive charge with every cycle. This leaves the inside of the neuron negative relative to the outside (setting up the **resting membrane potential** of about – 70mV.

Recommended Video Resource

- **Wendy Riggs: Action Potential 4 - Sodium potassium pump**: Walks step-by-step through the structural shape changes and ion movement across the membrane.
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Gemini:
Want to explore how this gradient sets up the resting membrane potential in Lecture 5?

Yes, as limited to your statement "Want to explore how this gradient sets up the resting membrane potential in Lecture 5?" As I will be wanting to study also lecture 5 separately. Nenad

In **Action Potential 5 - Resting membrane potential**, Wendy Riggs builds directly on the ion gradients established in Lecture 4. She breaks down the chemical and electrical makeup of the resting neuron in a straightforward, accessible way:

1. Setting the Stage: The Membrane as a Barrier

The cell membrane is a **semi-permeable barrier** [01:14]. Ions and large cellular molecules cannot freely cross the lipid bilayer on their own. Because the membrane traps internal components, the cell can establish two entirely different environments on either side:

 Extracellular Fluid (ECF): The fluid outside the neuron.

 Intracellular Fluid (ICF): The cytoplasm inside the neuron.

2. The Players: What Sits on Each Side

Riggs catalogs the chemical species that define the intracellular and extracellular spaces [01:51]:

Ion / Molecule	Where Concentration is Highest	Charge	Role / Note
Potassium (K^+)	**Inside** (Intracellular)	$+1$	Pumped in by Na^+/K^+ AT [01:51].
Sodium (Na^+)	**Outside** (Extracellular)	$+1$	Pumped out l Na^+/K^+ AT [01:51].
Proteins (A^-)	**Inside** (Intracellular)	**Negative** ($-$)	Cellular mach trapped insid contributes a pool of fixed negative cha [02:12].
Chloride (Cl^-)	**Outside** (Extracellular)	-1	High concent extracellular [03:00].
Calcium (Ca^{2+})	**Outside** (Extracellular)	$+2$	High concent extracellular [03:00].

3. How the -70 mV Potential is Defined and Measured

A **membrane potential** simply means a separation of electrical charges across the membrane, creating stored electrical potential energy [00:21].

- **The Voltmeter Setup:**

To measure this, scientists place a reference electrode in the extracellular fluid and insert a recording microelectrode inside the cell [05:36].

- **Setting the Ground (0 mV):**

By convention, the outside fluid is arbitrarily designated as the reference zero point: Outside = 0 mV [04:28].

- **The Reading:**

Comparing the inside to that outside reference yields **-70 mV** [03:55]. This negative number means the interior surface of the membrane has an excess of negative charges relative to the outside.

4. What Causes the Net Negative Inside?

Riggs highlights two primary factors in this lecture:

1. **The Pump's Asymmetry (Electrogenic Nature):**

The sodium-potassium pump constantly moves [3 $Na^{+]}$ out for every [2 $K^{+]}$ [05:11]. Because it expels more positive charges than it takes in, each cycle leaves the interior slightly negative relative to the exterior.

2. **Fixed Internal Anions (Proteins):**

The cell is packed with structural and functional proteins that carry negative charges [02:12]. Because they are large, they cannot exit through the membrane, keeping a permanent reservoir of negative charge inside.

(In standard neurophysiology, the selective "leakiness" of non-gated potassium channels allows positive [K^+] to diffuse outward down its concentration gradient, leaving behind those negative proteins and pulling the resting potential near -70mV -- a concept Riggs queues up at the conclusion of this lecture when asking the student to speculate how charged particles will move [06:23]).

Primary Video Reference

- **Wendy Riggs: Action Potential 5 - Resting membrane potential** — Covers the voltmeter measurement convention, the ion inventory, and how the internal environment maintains its resting baseline.

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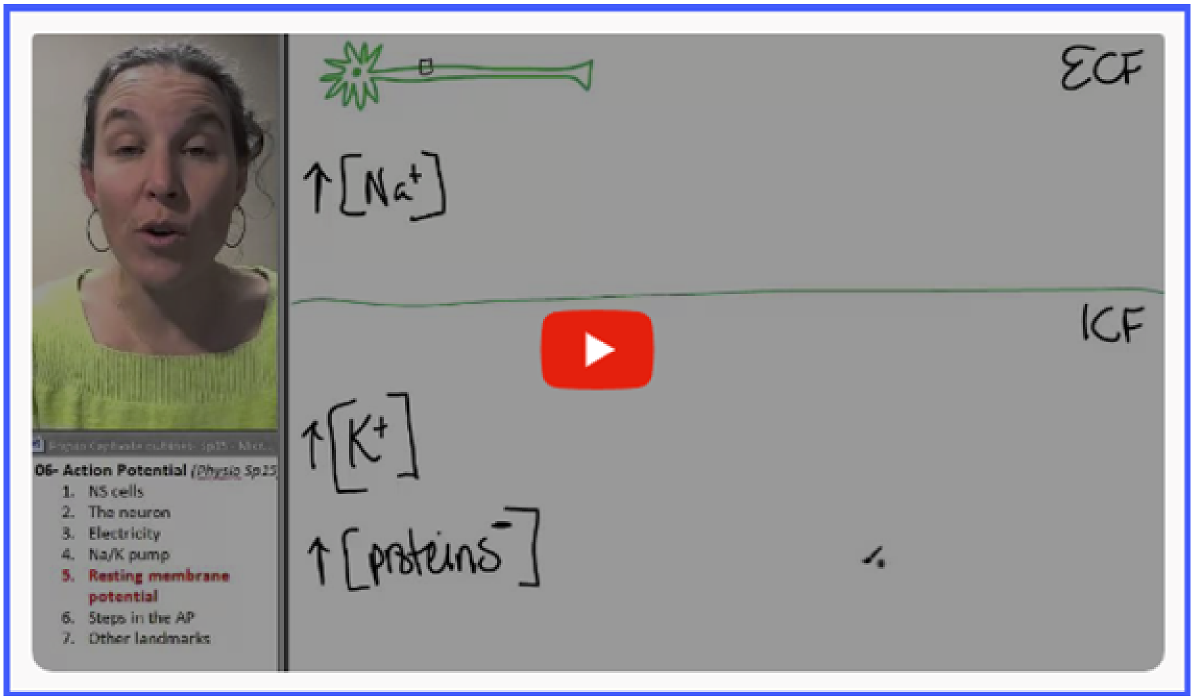
- Action Potential 5- Resting membrane potential [http://www.youtube.com/watch?v=J2yZ7ZTjsBE]
- Wendy Riggs · 28K views



[https://www.youtube.com/channel/UC-yQpFb89u7qb-duWMZvoog] This is link to Wendy's Action Potential 5 lecture, Resting Membrane Potential on Youtube.com

This presentation of Wendy Riggs 4th lecture on the Action Potential Series (See youtube.com) is provided by Nenad of Serbia and Google Gemini AI targeted at 9th grade Highschool and above as part of https://the-cardiac-engine.net in support of self-tutoring to learn in-depth about the electrocardiogram as instrument to help in establishing heart health. This presentation is rev.1, 2026-09-27