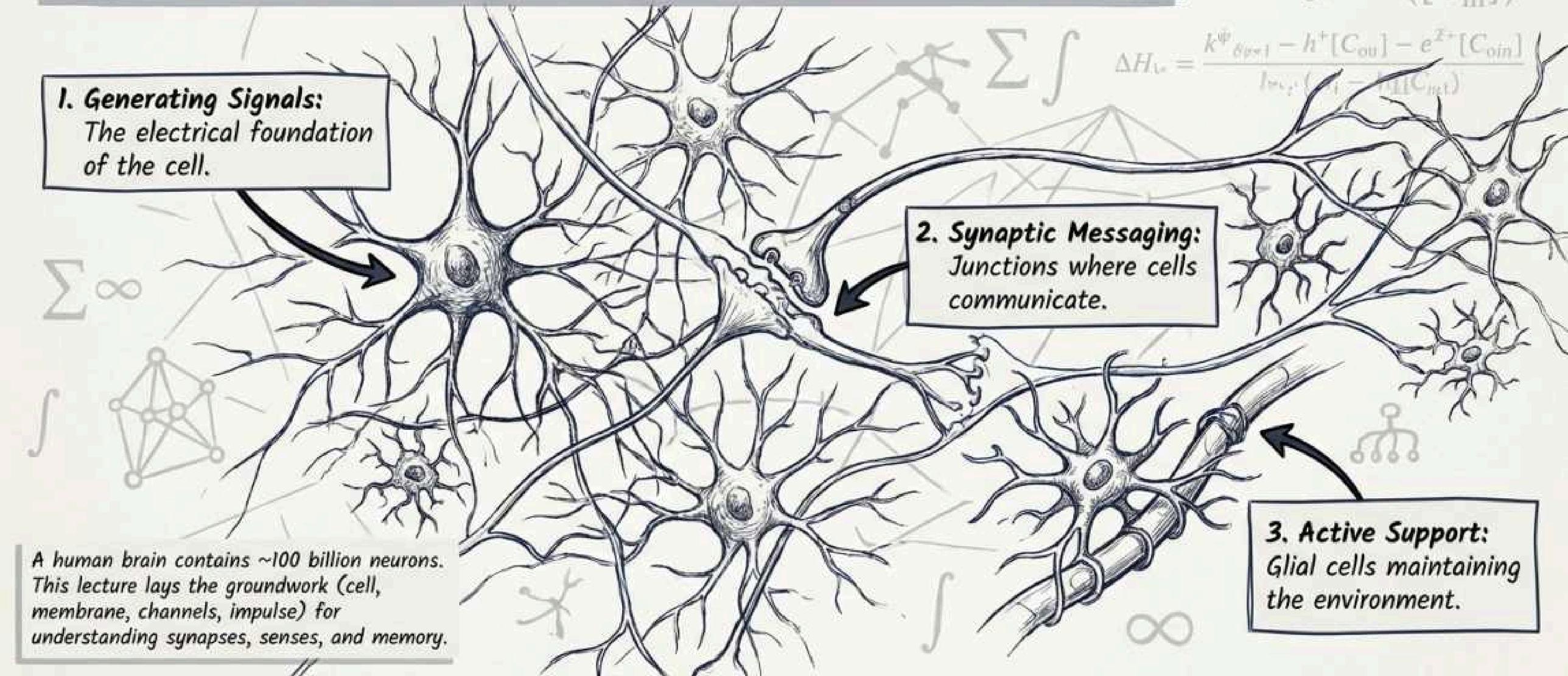
MED 513 B: Neurons, Glia and Electrical Signals

A distributed network, not a centrally controlled machine.



1. Generating Signals:
The electrical foundation of the cell.

2. Synaptic Messaging:
Junctions where cells communicate.

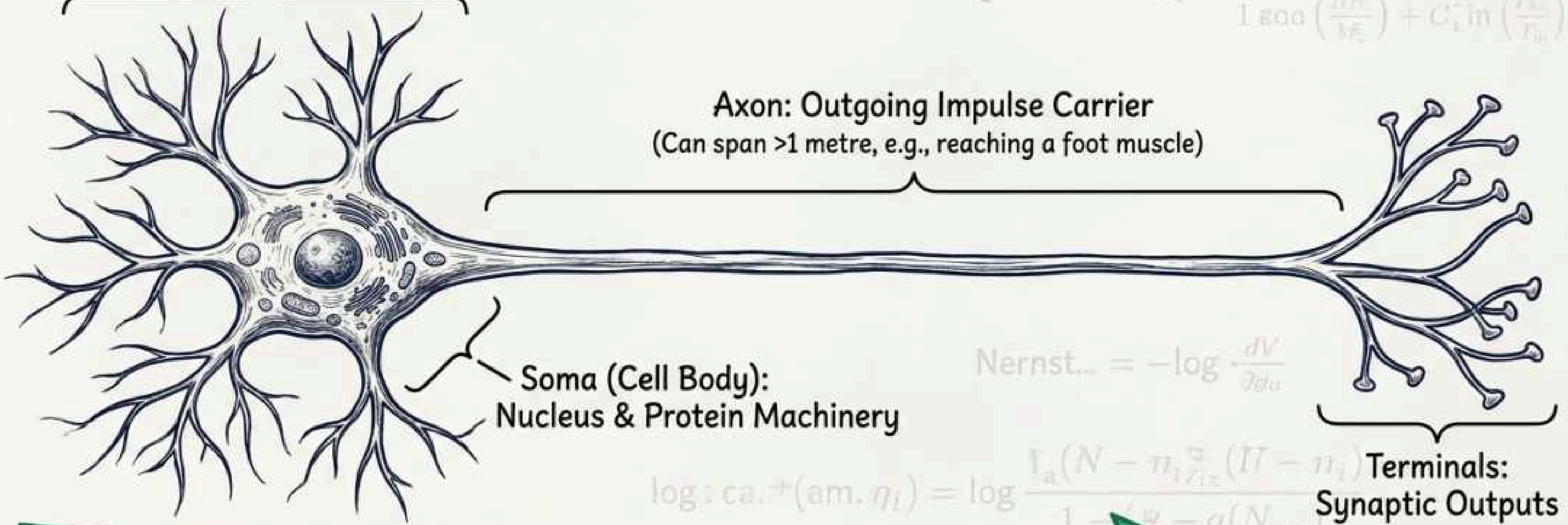
3. Active Support:
Glial cells maintaining the environment.

A human brain contains ~100 billion neurons. This lecture lays the groundwork (cell, membrane, channels, impulse) for understanding synapses, senses, and memory.

The Polarised Plan of the Neuron

¶ 1.2

Dendrites: The Principal Receiving Surface
(gathers chemical messages)



Axon: Outgoing Impulse Carrier
(Can span >1 metre, e.g., reaching a foot muscle)

Soma (Cell Body):
Nucleus & Protein Machinery

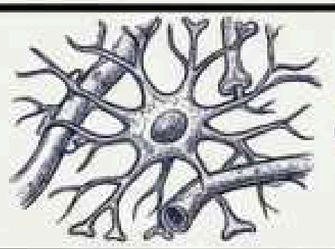
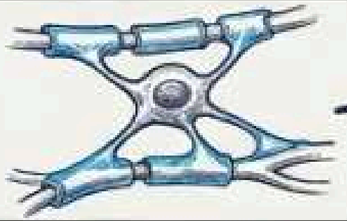
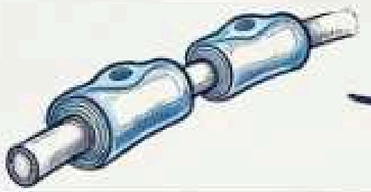
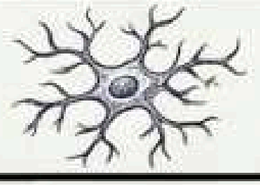
Terminals:
Synaptic Outputs

Direction of Information Flow: Receiving → Deciding → Sending.

Disclaimer: This polarised plan is a useful ideal; real neurons vary widely in shape to compute different circuits.

Glial Cells: Active Partners in Signalling

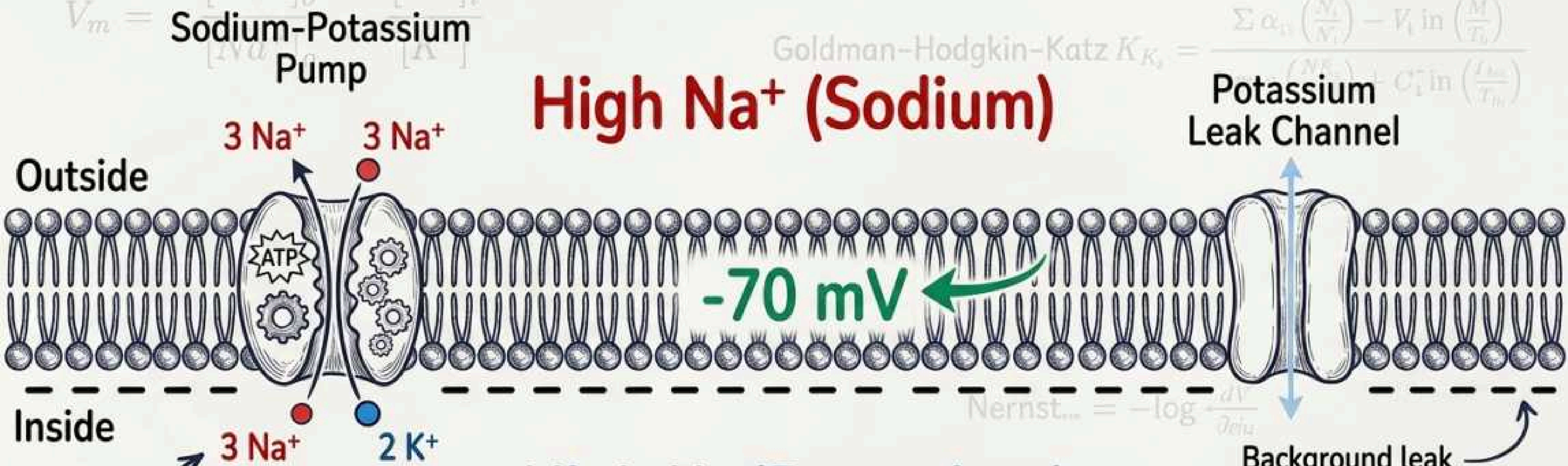
¶ 1.3

Comparison Matrix	Primary Function	Location/Domain
Astrocytes 	Regulate synapse chemical environment, control blood flow, take up released transmitters.	CNS
Oligodendrocytes 	Wrap axons in insulating myelin.	Central Nervous System (CNS)
Schwann Cells 	Wrap axons in insulating myelin.	Peripheral Nerves (PNS)
Microglia 	Brain's resident immune cells; survey tissue and respond to injury/inflammation.	CNS

Key Insight: Modern consensus: Glia are essential partners in the signalling system, not just a passive backdrop.

The Resting Membrane Potential (-70 mV)

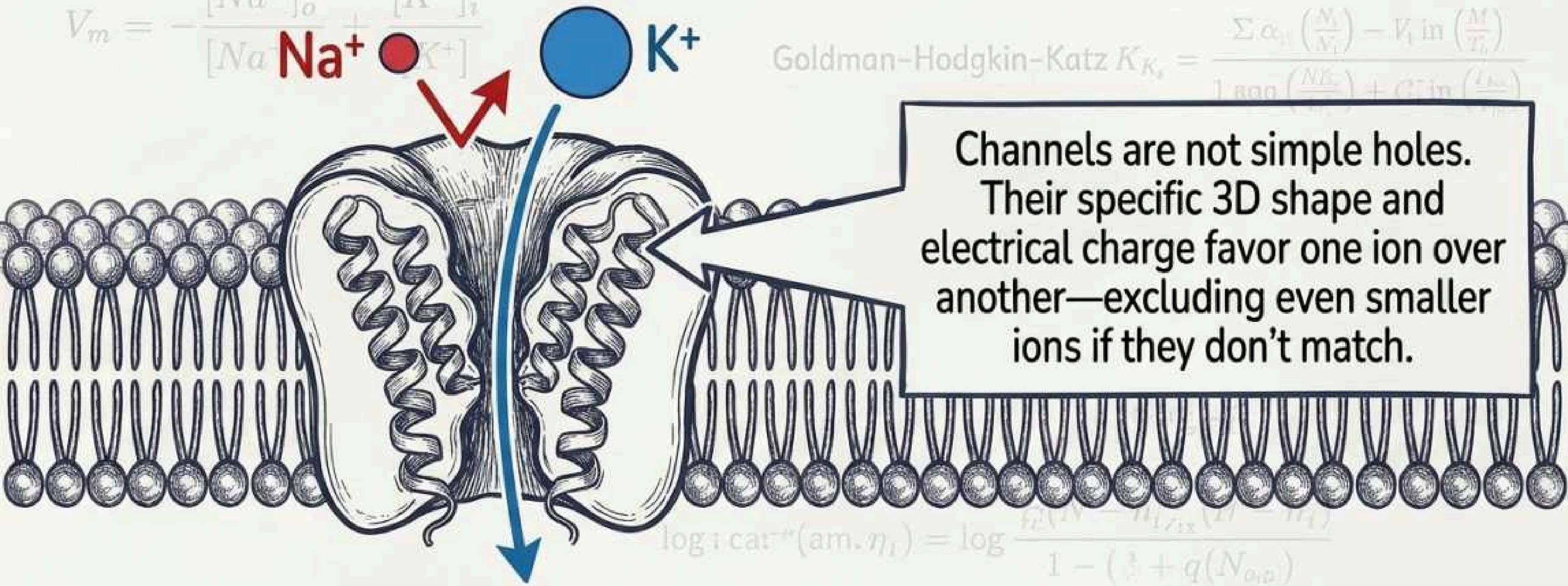
¶ 1.4



The resting state is STORED ENERGY, ready to be spent in a brief, controlled change.

Ion Channels: The Quiet Marvel of Selectivity

¶ 1.5



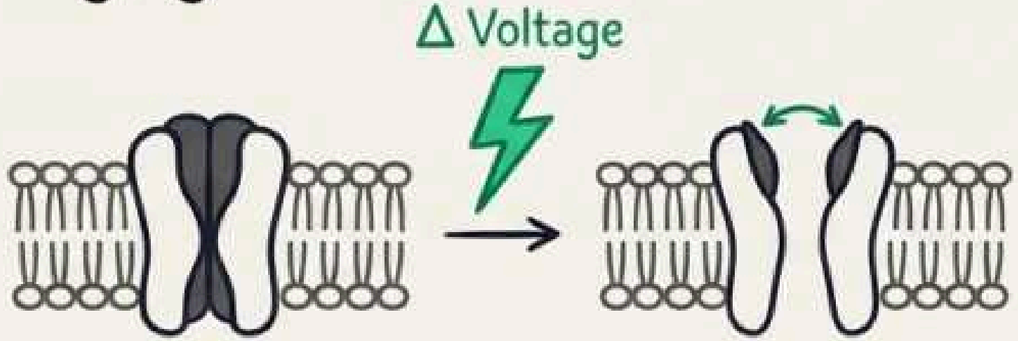
Channels are not simple holes. Their specific 3D shape and electrical charge favor one ion over another—excluding even smaller ions if they don't match.

Scale of Impact: Currents are tiny, but sufficient to alter voltage across a membrane only a few millionths of a millimetre thick.

Forward Link: When later lectures mention chemicals opening or blocking channels, they refer to this exact microscopic device.

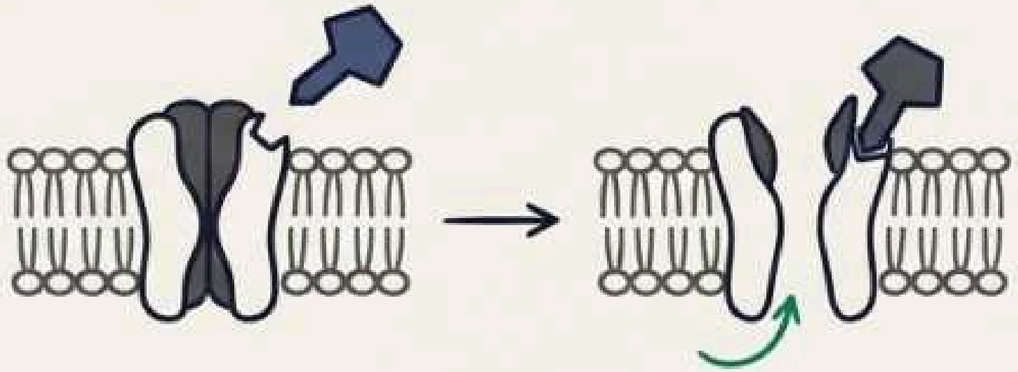
Gating: Designed Sensitivity to Signals

Voltage-gated

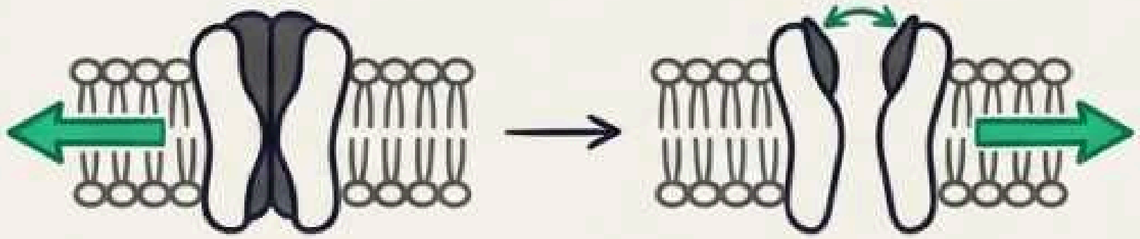


Essential for the travelling impulse.

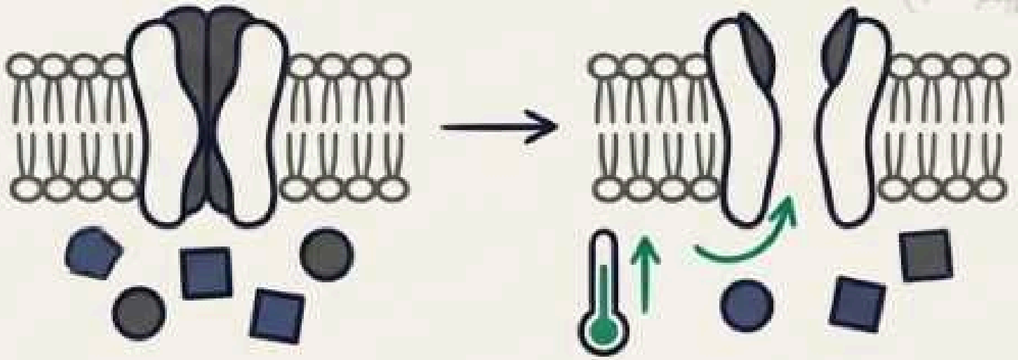
Ligand-gated



Mechanical



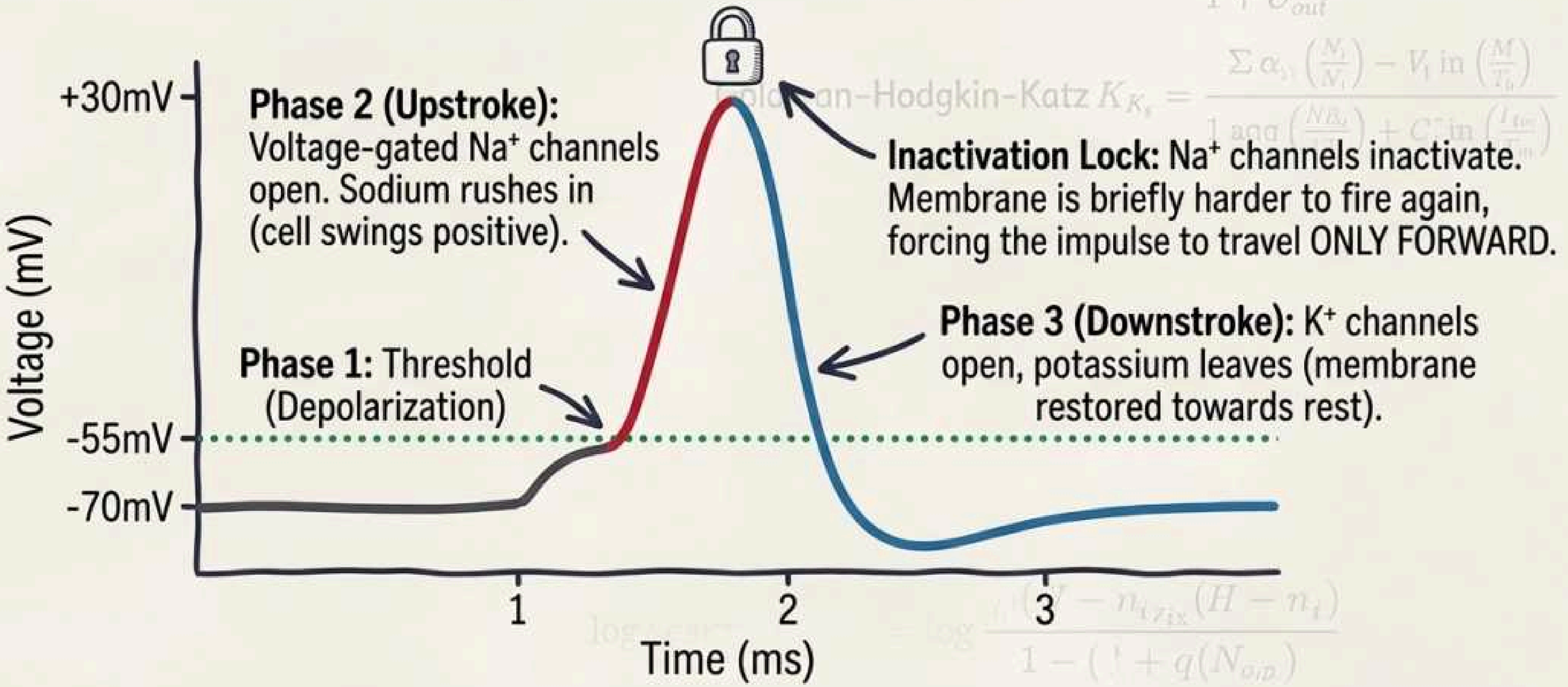
Internal/Temp



Synthesis Note: A single neuron carries many kinds of channels. Gating is a normal, designed sensitivity—disease often begins when this timing or selectivity fails.

The Action Potential: An All-or-None Message

¶ 1.7

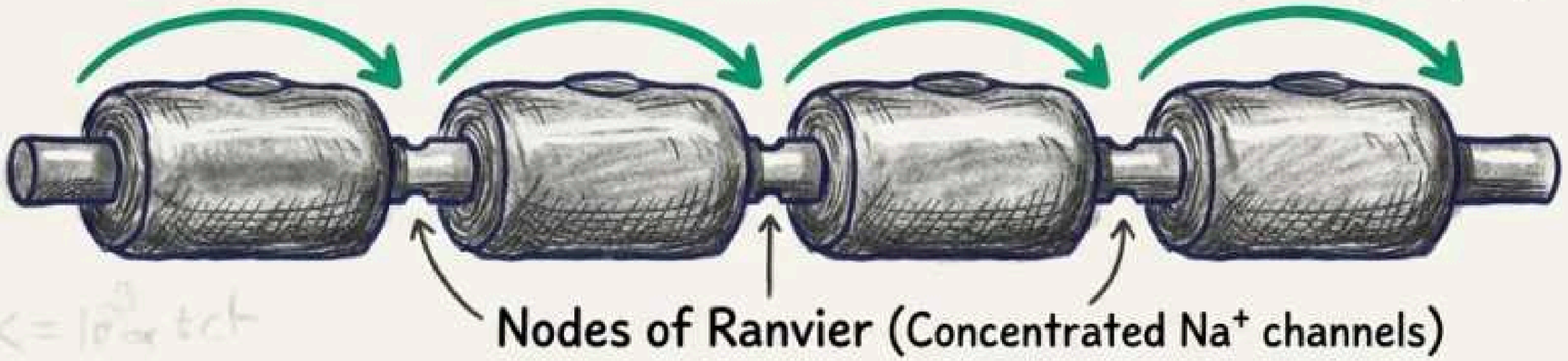


Historical Note: Foundation built on mid-20th-century squid giant axon studies.

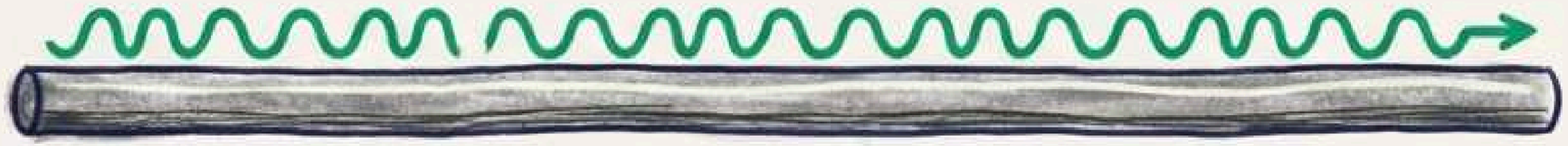
Key Principle: The event is ALL-OR-NONE. Once the threshold is crossed, the spike runs to completion (it does not grow based on a "weak shove").

Conduction Speed: The Role of Axon Geometry and Myelin

Saltatory Conduction: Faster and more economical impulse jumping.



Slow, continuous spread. (Used by fibres carrying dull pain or autonomic signals).



Physical Factors:

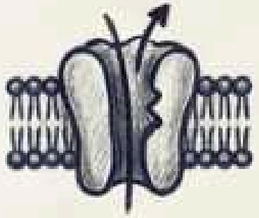
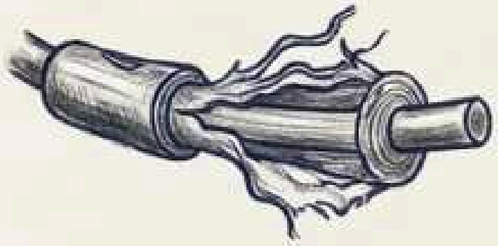
Large-diameter axons conduct faster than thin ones.

Pathology Note:

When myelin is damaged, signals slow, fragment, or fail (looking like a disorder of the nerve cell itself).

Clinical Shadows of Cellular Facts

Diagnostic Split

Cellular Failures	Clinical Manifestations
 Channel opens too easily or fails to close	→ Result: Cell fires when it should be quiet.
 Myelin is stripped away	→ Result: Command to muscle arrives late or not at all.

Urgent Care Warning Box:

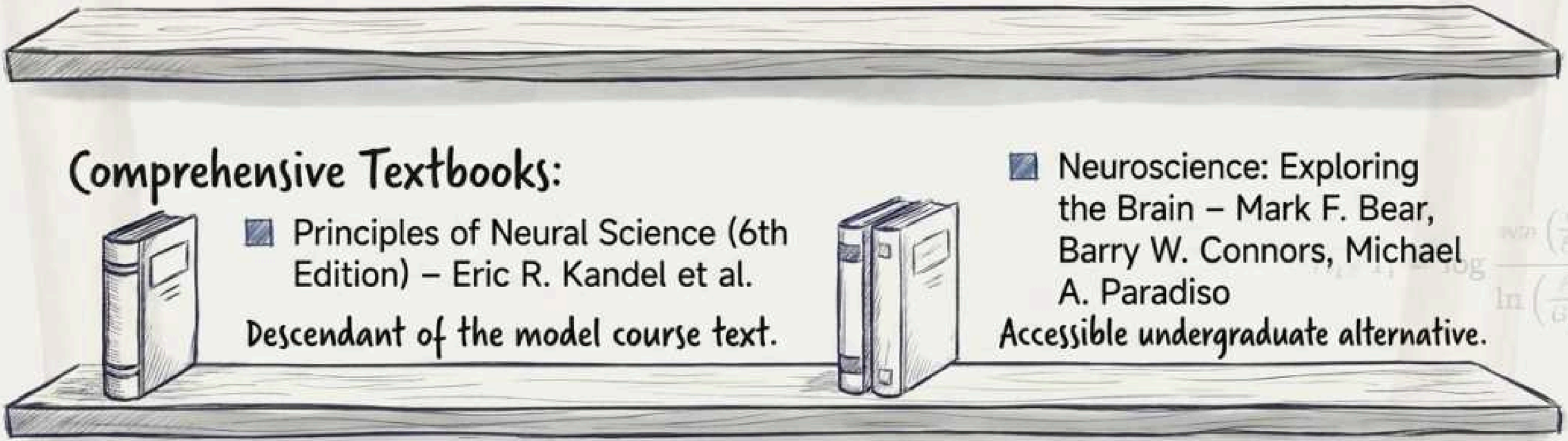
Sudden weakness, sudden trouble speaking, or a first seizure = URGENT CARE. These are not puzzles to solve from a book.

Scientific Truth: Electricity in the nervous system is NOT a metaphor. It is the literal, controlled movement of ions through gated proteins.

Foundational References for Further Study

Open Starting Points:

- OpenCourseWare: HST.131 (Dr. David Corey et al., 2005) – Early sessions on ion channels, neurons, synapses, and conduction.
- Grokipedia: Core articles on the neuron, glia, membrane potential, ion channels, action potential, myelin, and saltatory conduction.



Comprehensive Textbooks:

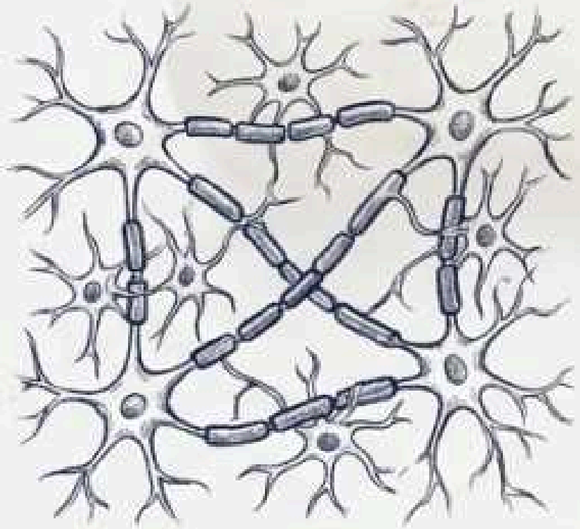
- Principles of Neural Science (6th Edition) – Eric R. Kandel et al.

Descendant of the model course text.

- Neuroscience: Exploring the Brain – Mark F. Bear, Barry W. Connors, Michael A. Paradiso

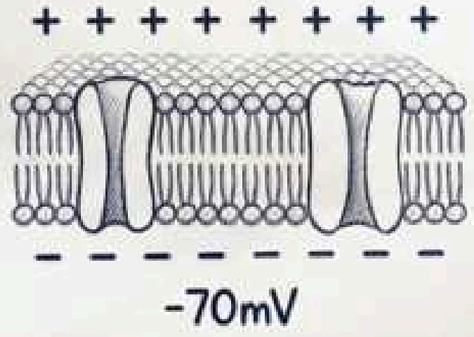
Accessible undergraduate alternative.

Synthesis & Look Ahead



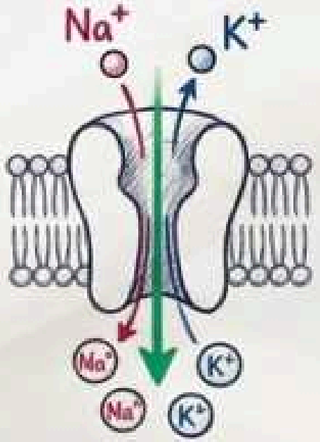
Network of polarised neurons & active glia

+



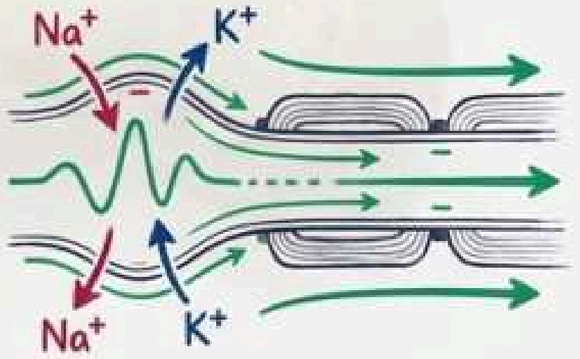
Resting membrane's stored energy (-70mV)

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Gated ion channels

=



The travelling, all-or-none electrical impulse

(Speed dictated by myelin & axon size).

Next in Lecture 2: Moving from the single axon to the synapse, exploring how this electrical impulse is translated into chemical messages.