Foundations of Psychophysiology

Part 2.2: Neurons and neuronal signalling

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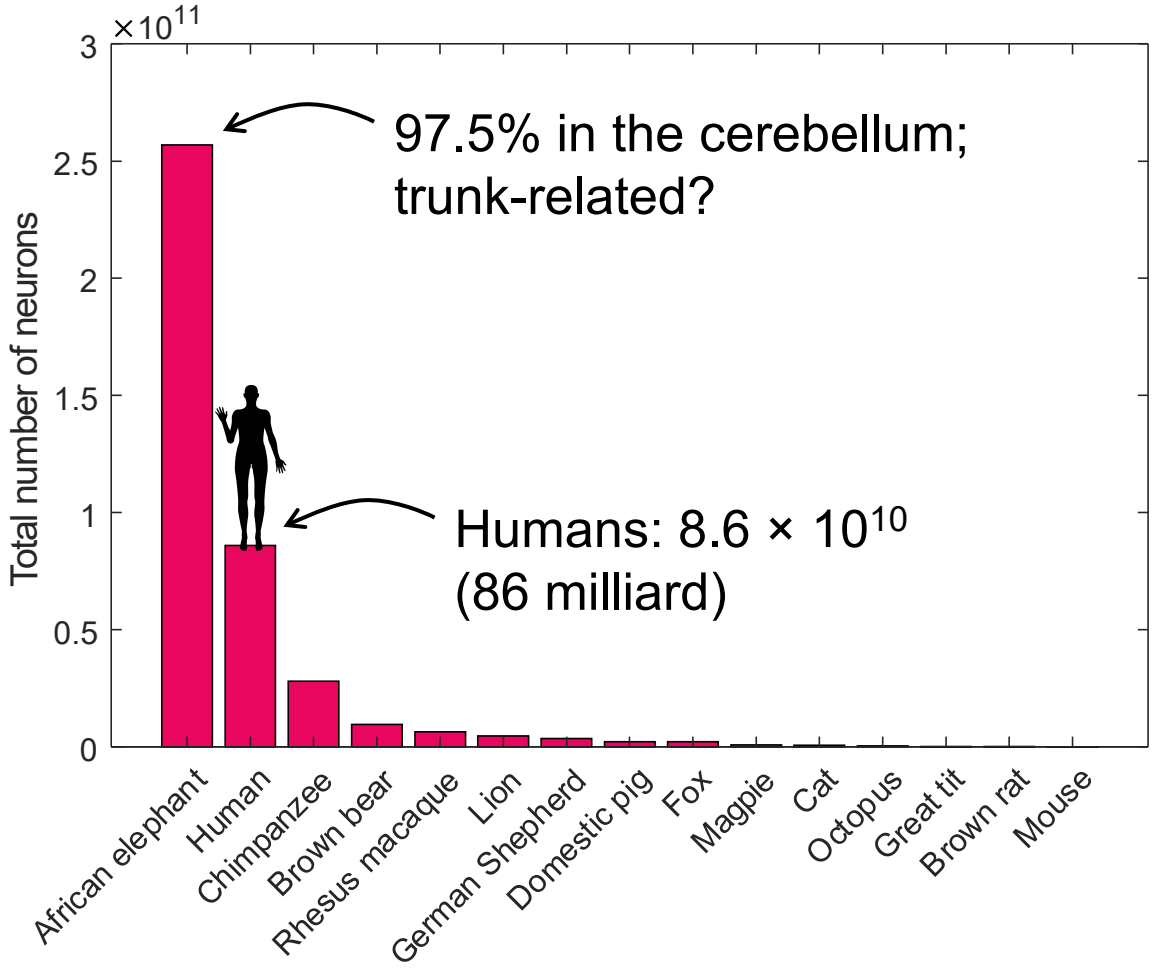
NEUROADAPTIVE
HUMAN-COMPUTER
INTERACTION

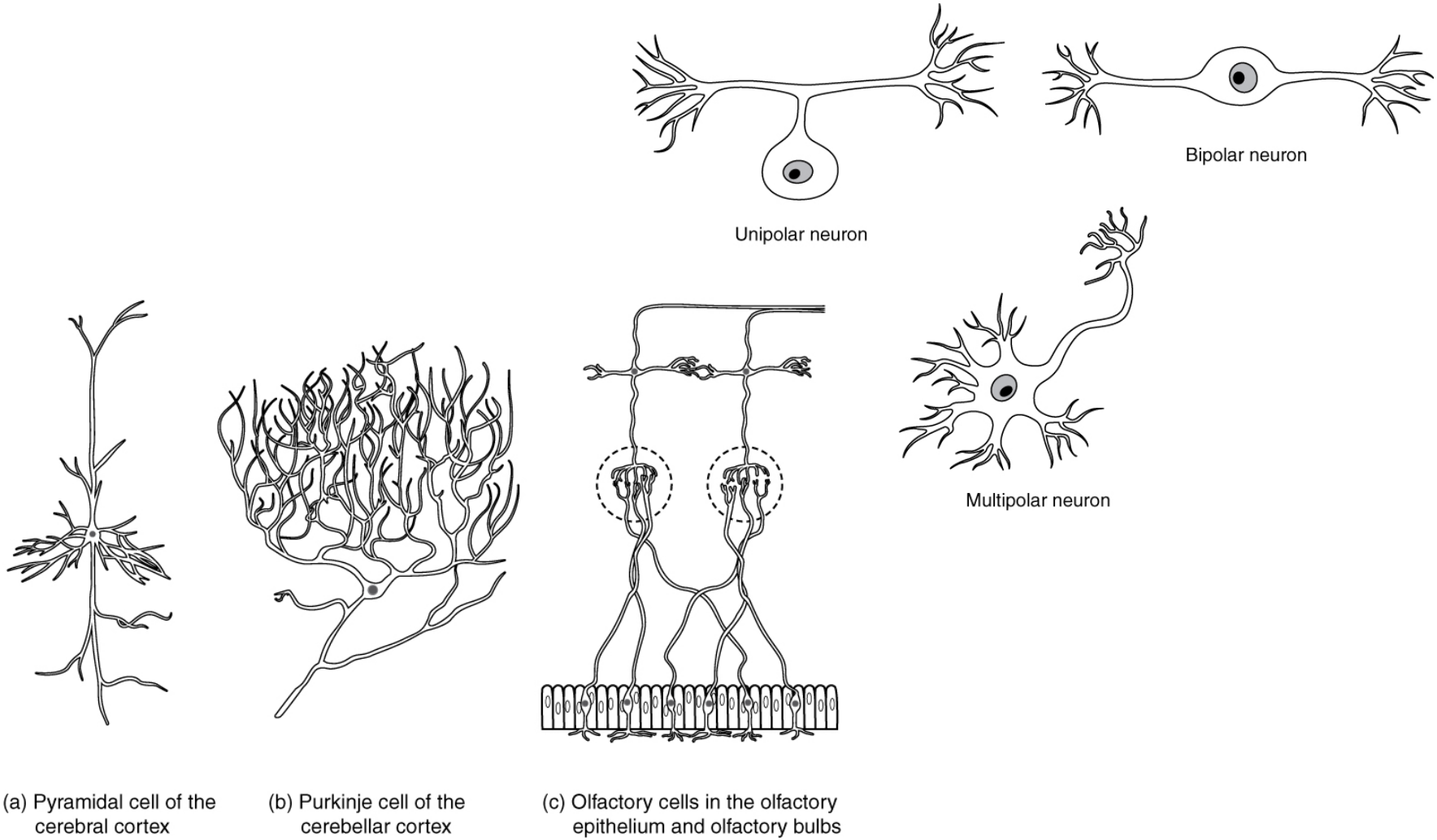
Brandenburg
University of Technology
Cottbus - Senftenberg

The neuron

The neuron is the main functional unit of the nervous system, capable of integrating and transmitting signals.



Types of neurons: Structural



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Types of neurons: Functional

- Sensory neurons (afferent neurons)

  are activated by various stimuli, and transmit activity to other neurons.

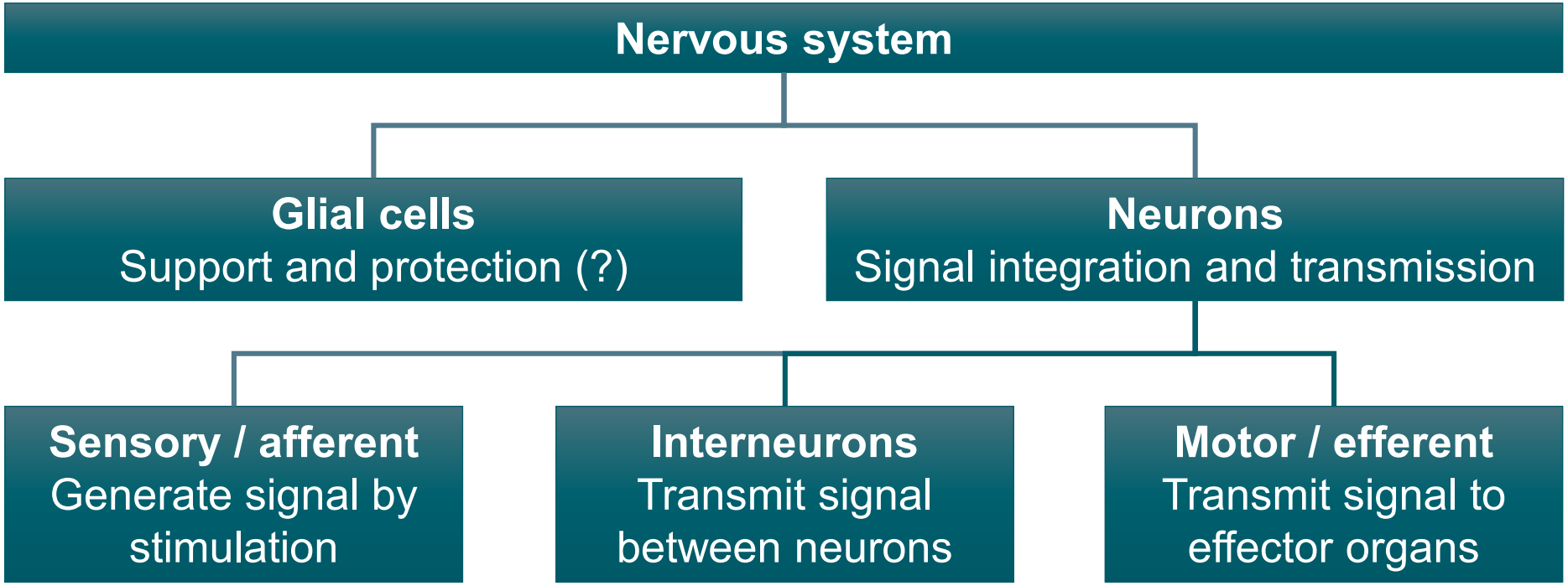
- Interneurons

  receive signals from, and transmit signals to, other neurons.

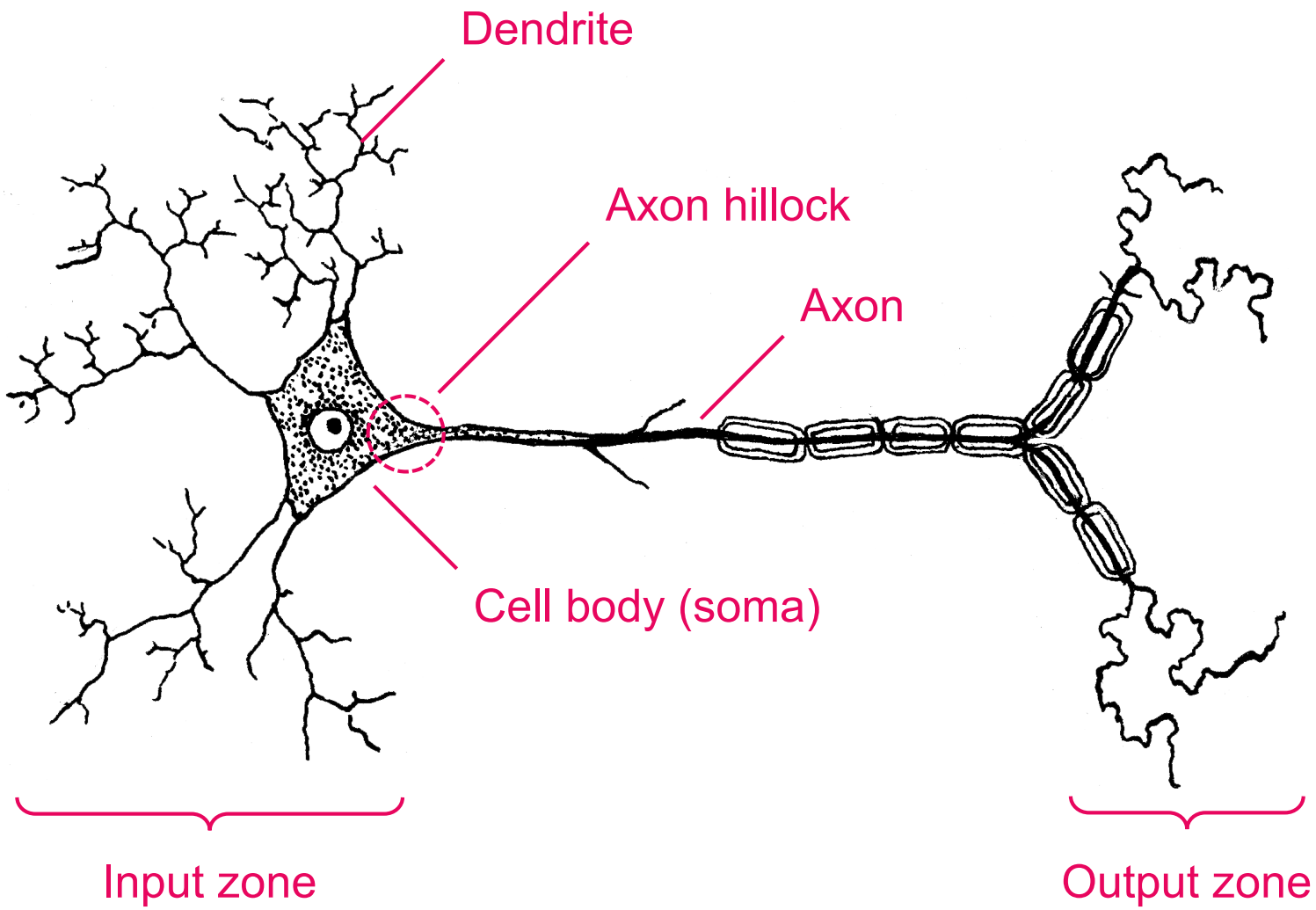
- Motor neurons (efferent neurons)

  receive signals from other neurons, and transmit activity to effector organs.

Overview

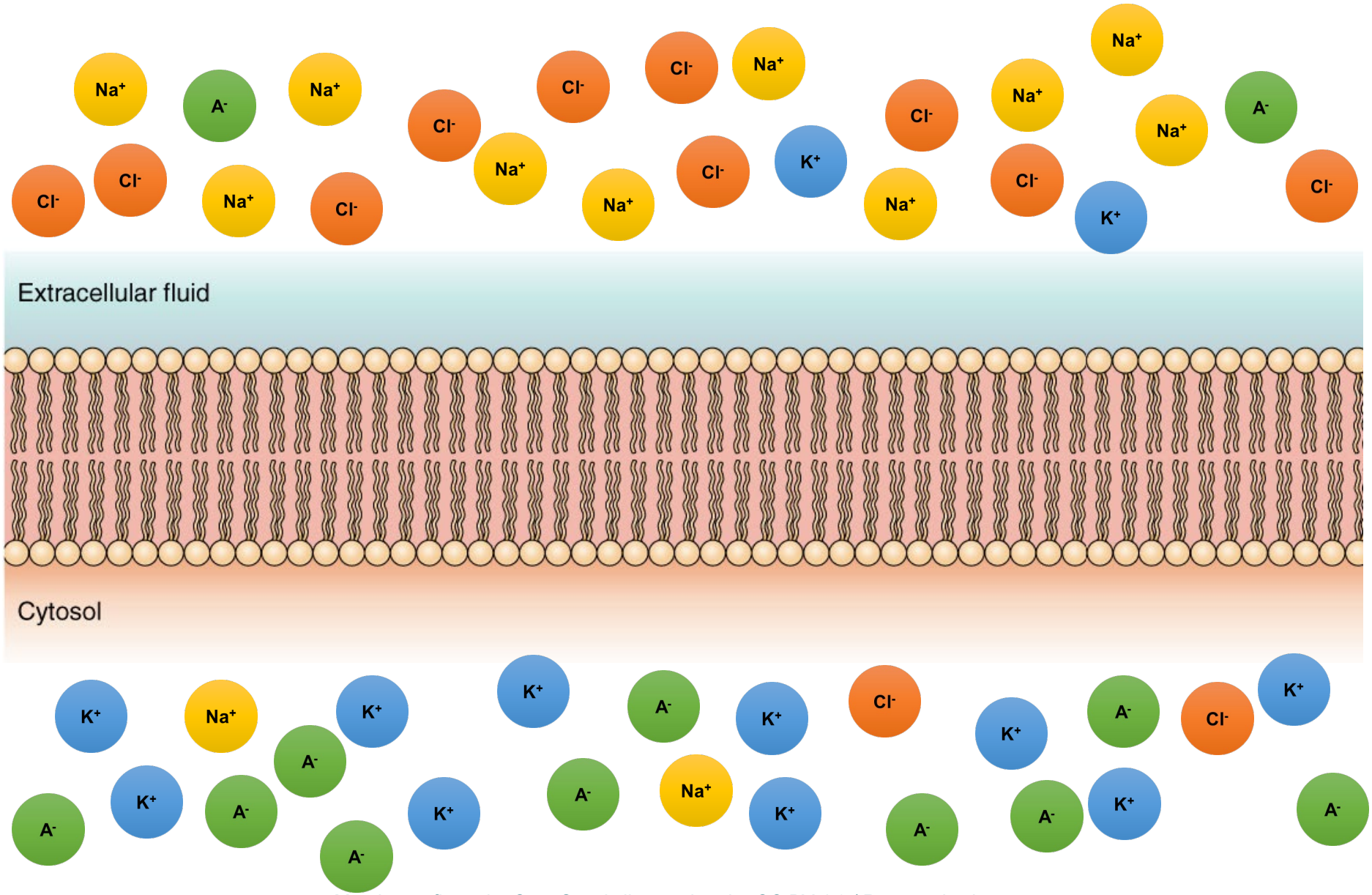

Nervous system
Glial cells
Support and protection (?)
Neurons
Signal integration and transmission
Sensory / afferent
Generate signal by stimulation
Interneurons
Transmit signal between neurons
Motor / efferent
Transmit signal to effector organs

Basic neuron histology



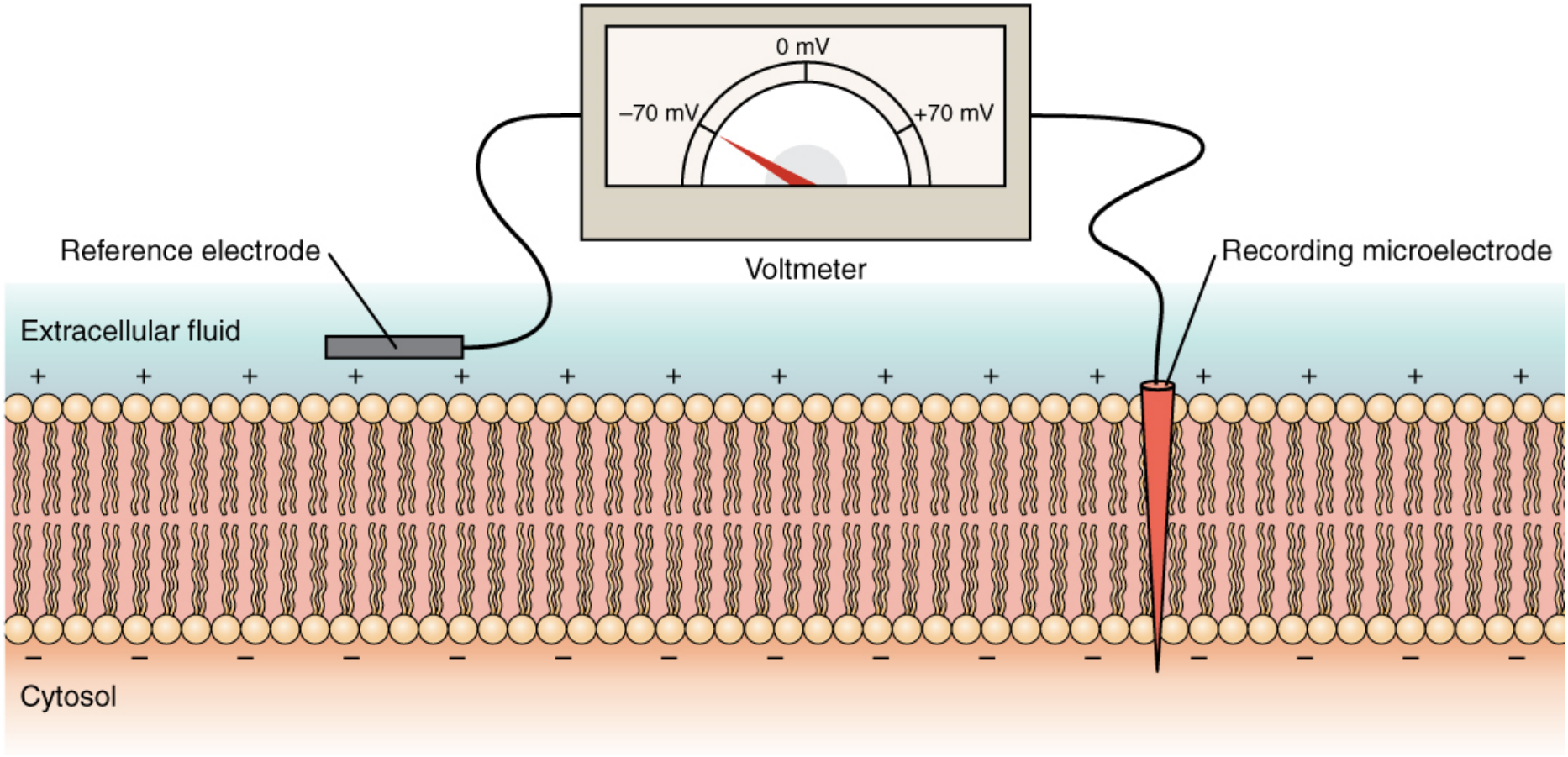
Neuron figure by Pearson Scott Foreman is in the public domain

The neuron at rest



Membrane figure by OpenStax is licensed under CC BY 4.0 / Removed voltmeter

The neuron at rest



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The neuron at rest

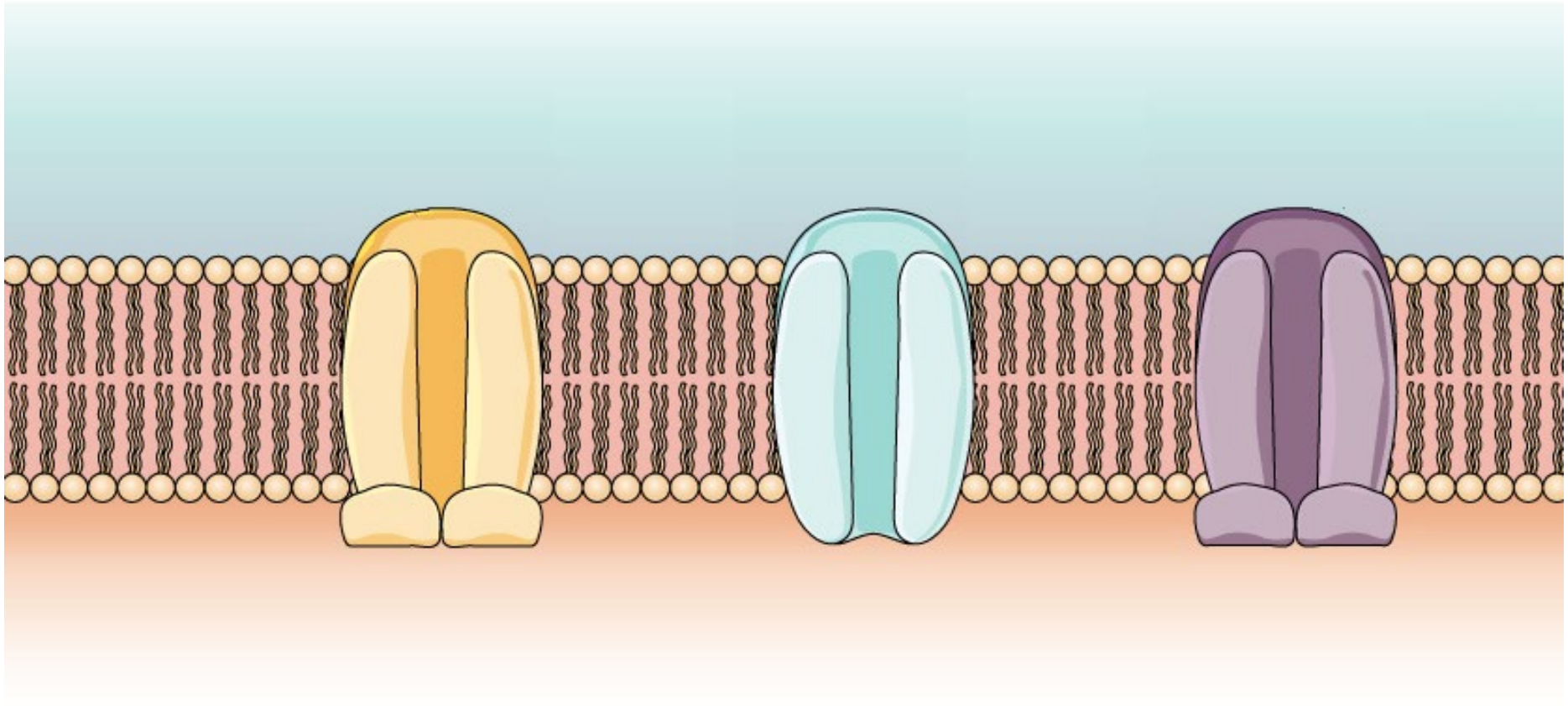
The resting potential of neurons is approximately -70 mV.

It is maintained by the Na^+/K^+ pump (sodium-potassium pump), which actively transports Na^+ ions outwards, and K^+ ions inwards.

Aside from the Na^+/K^+ pump, there are a number of gates in the cell membrane that can open and close under different circumstances.

This can change the potential across the membrane.

Ion channels / “gates”



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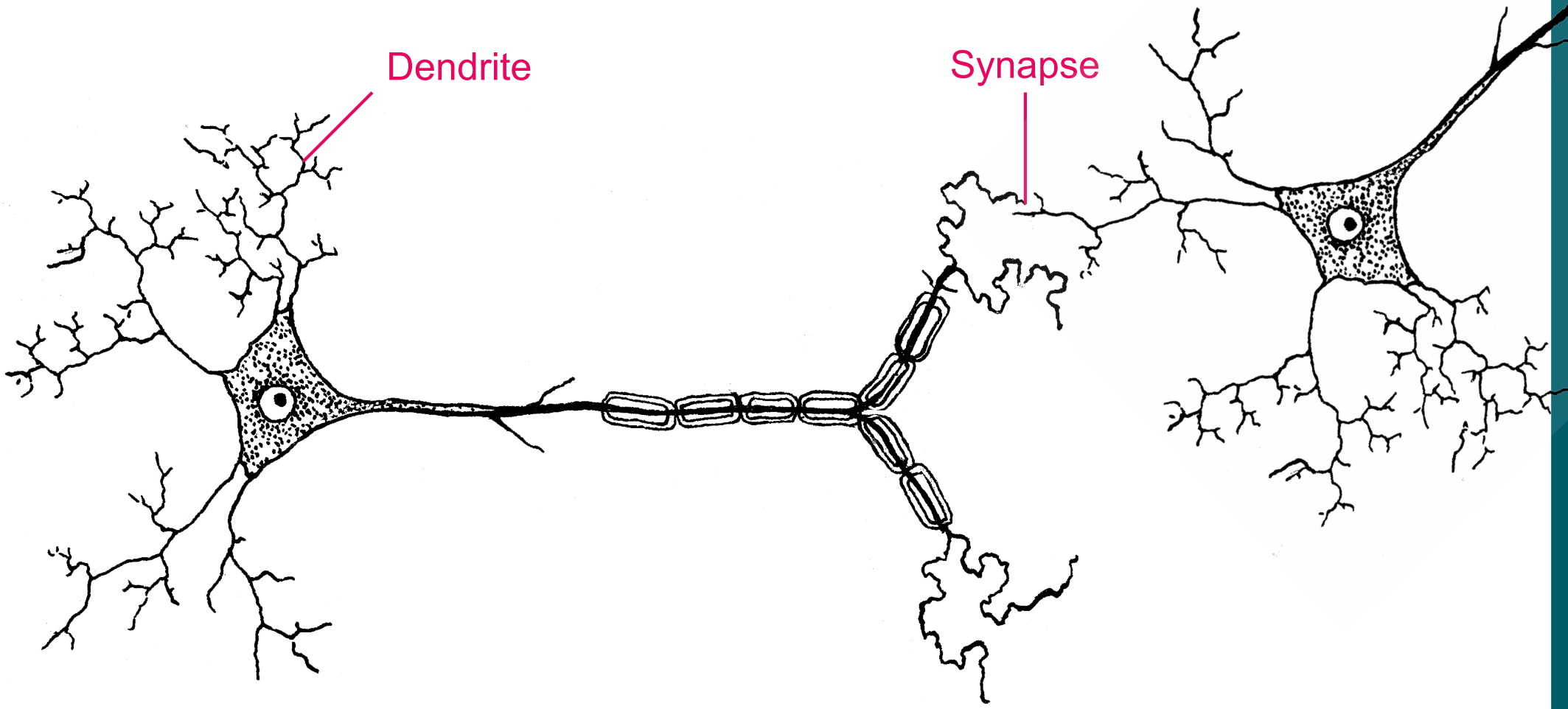
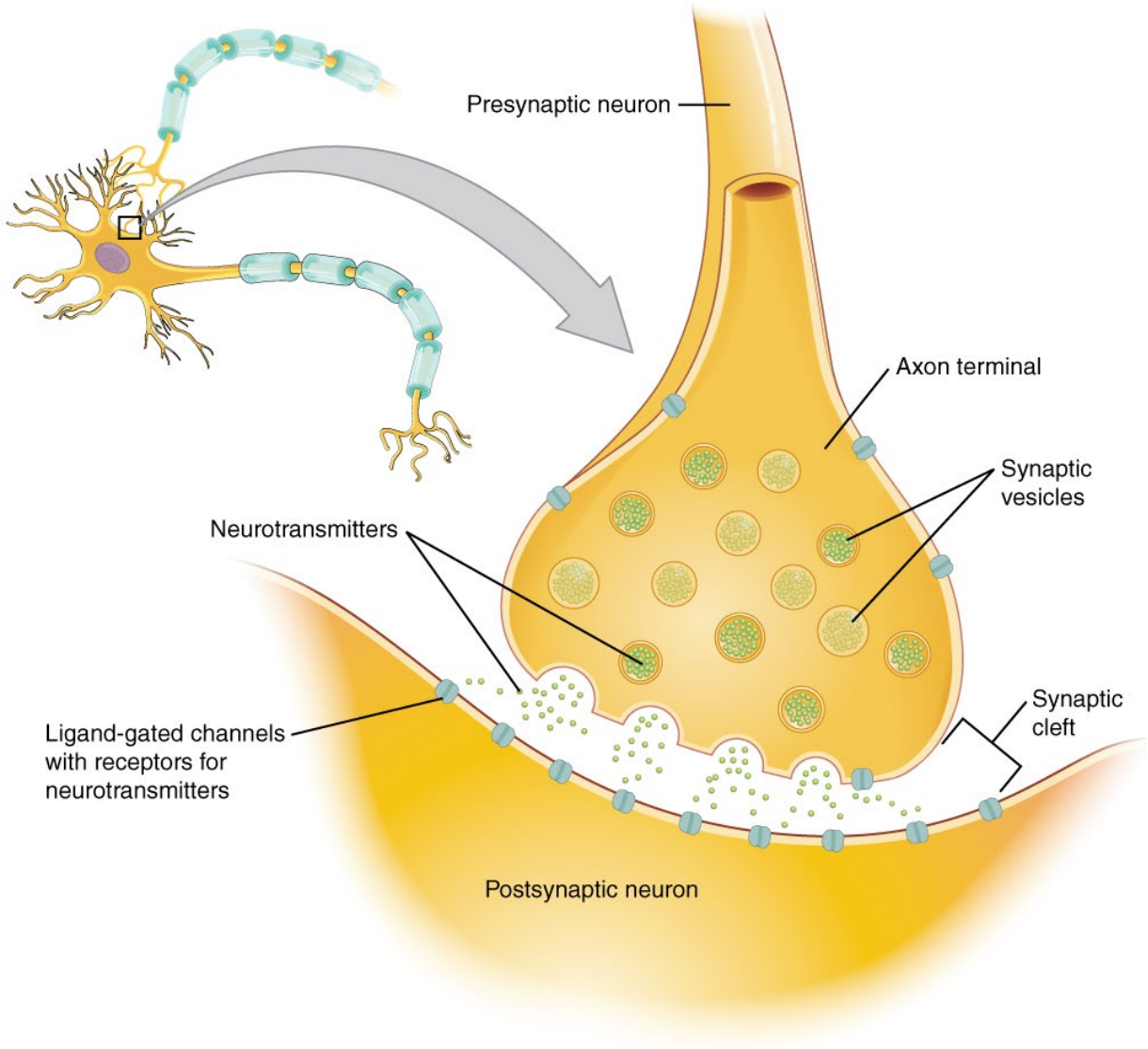
Postsynaptic potentials



Psychophysiology: Neurons: Postsynaptic potentials

The synapse



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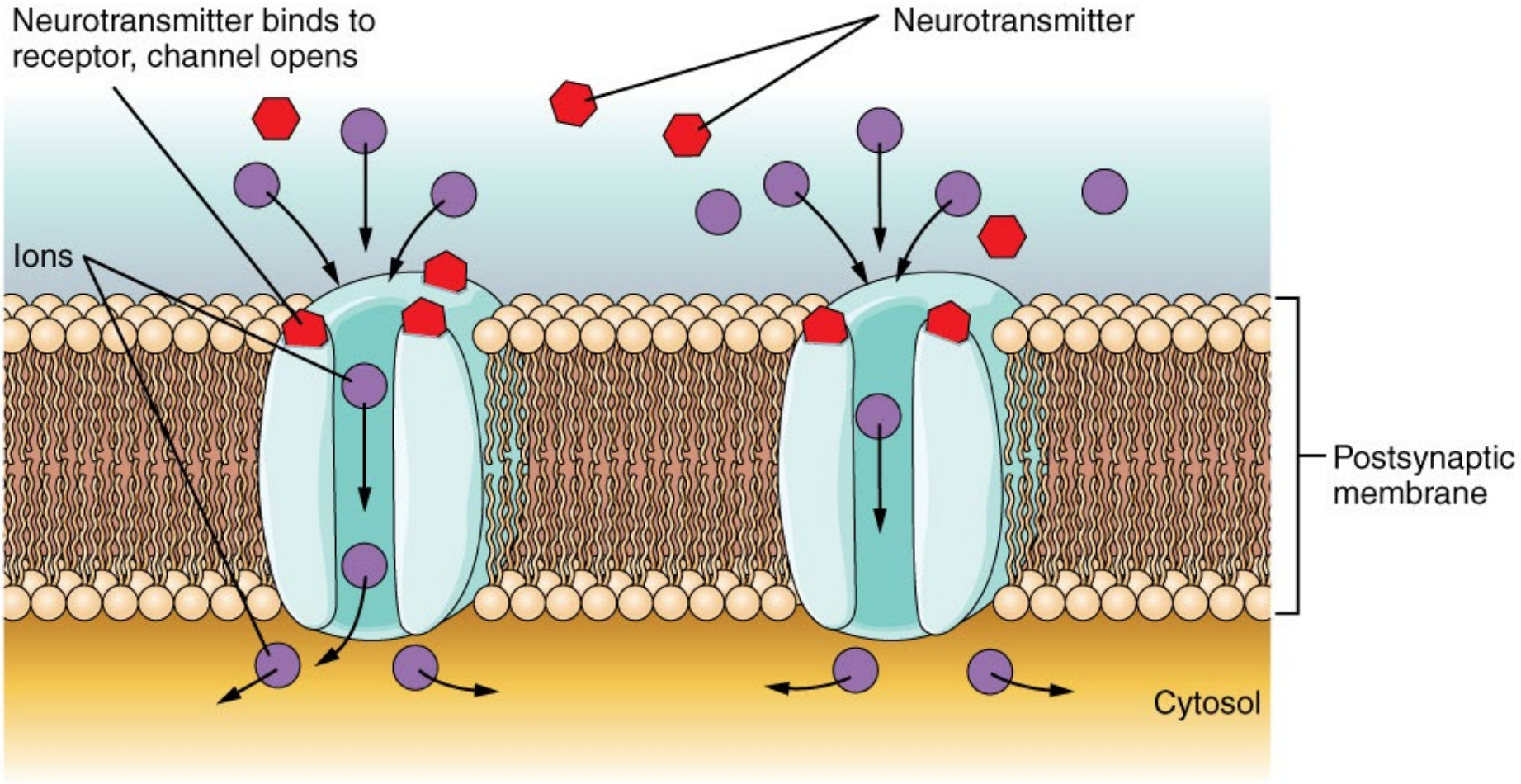
Neurotransmitter



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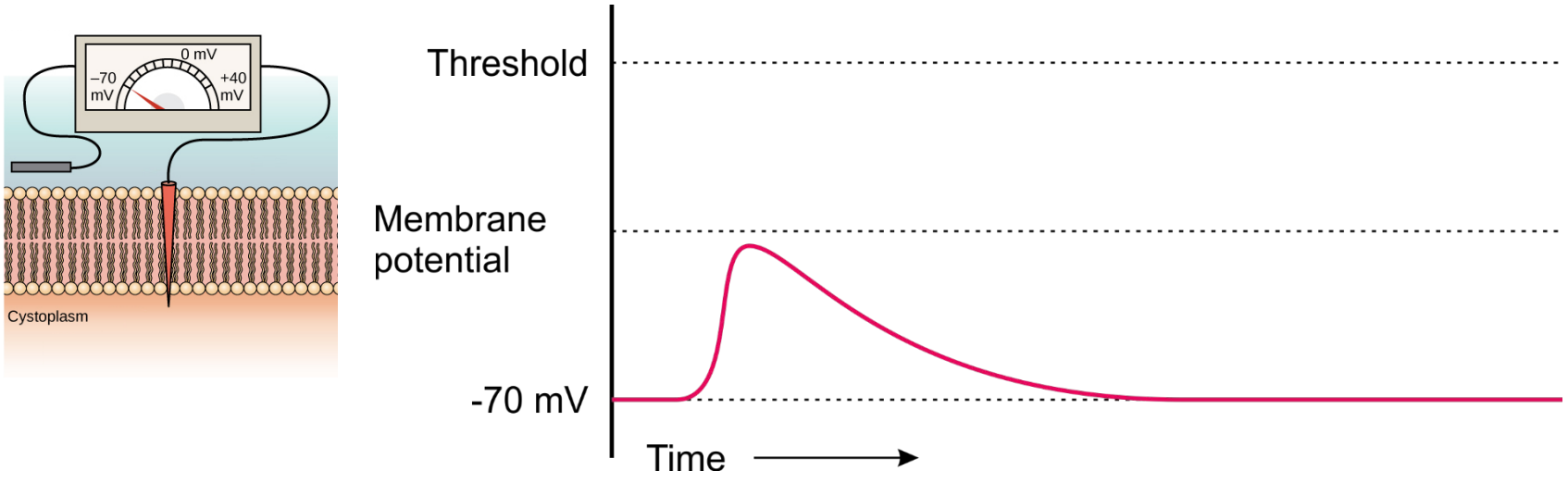
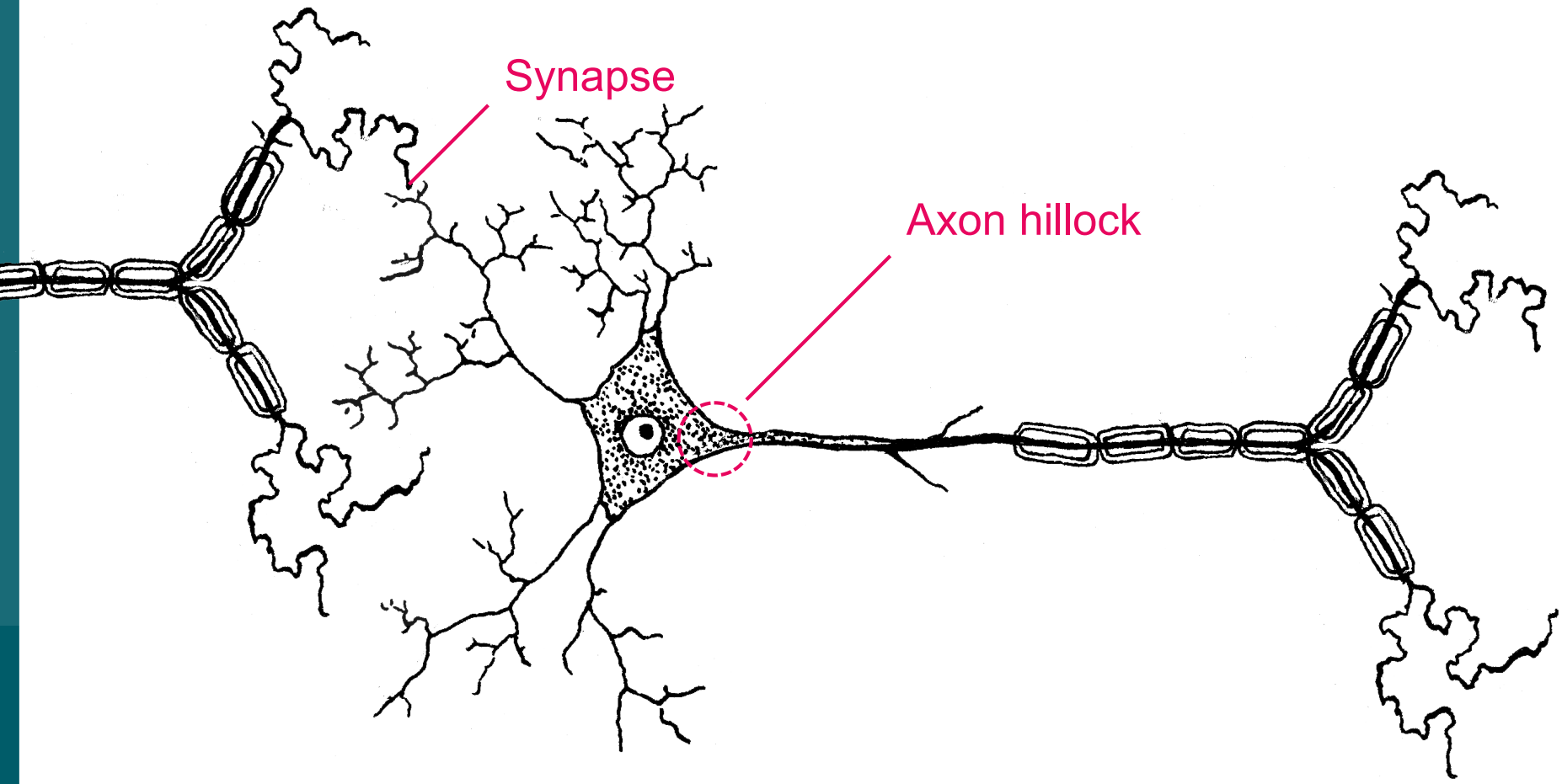
Postsynaptic potentials

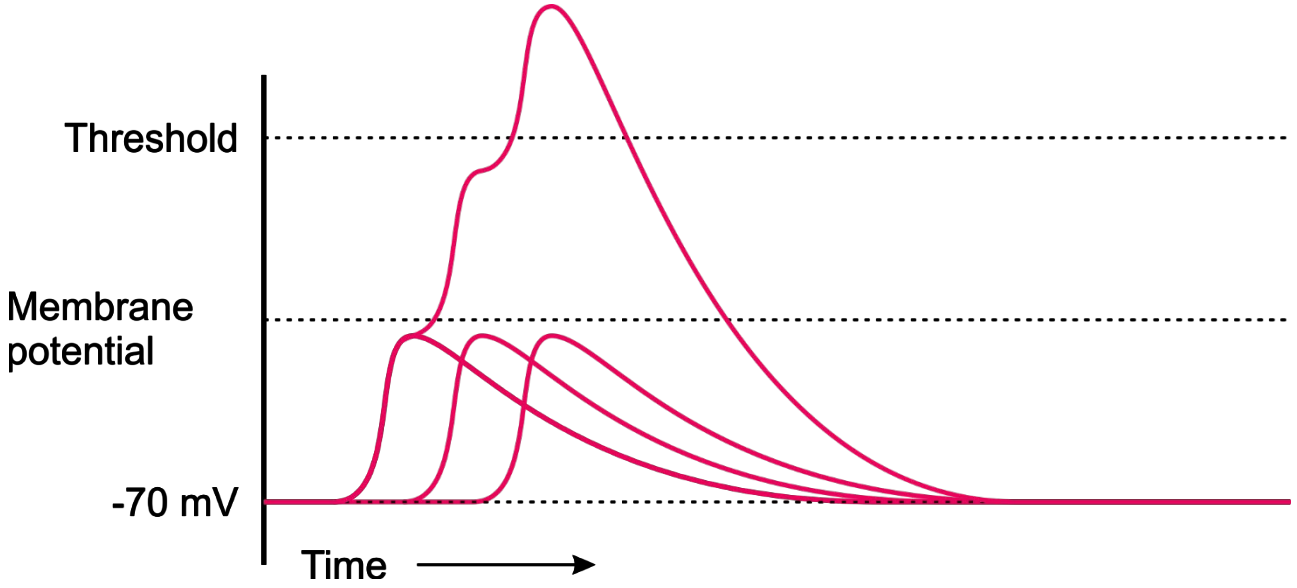


Voltmeter figure from OpenStax is licensed under CC BY 4.0
Potential figure by the author is in the public domain

Temporal and spatial summation



Temporal summation



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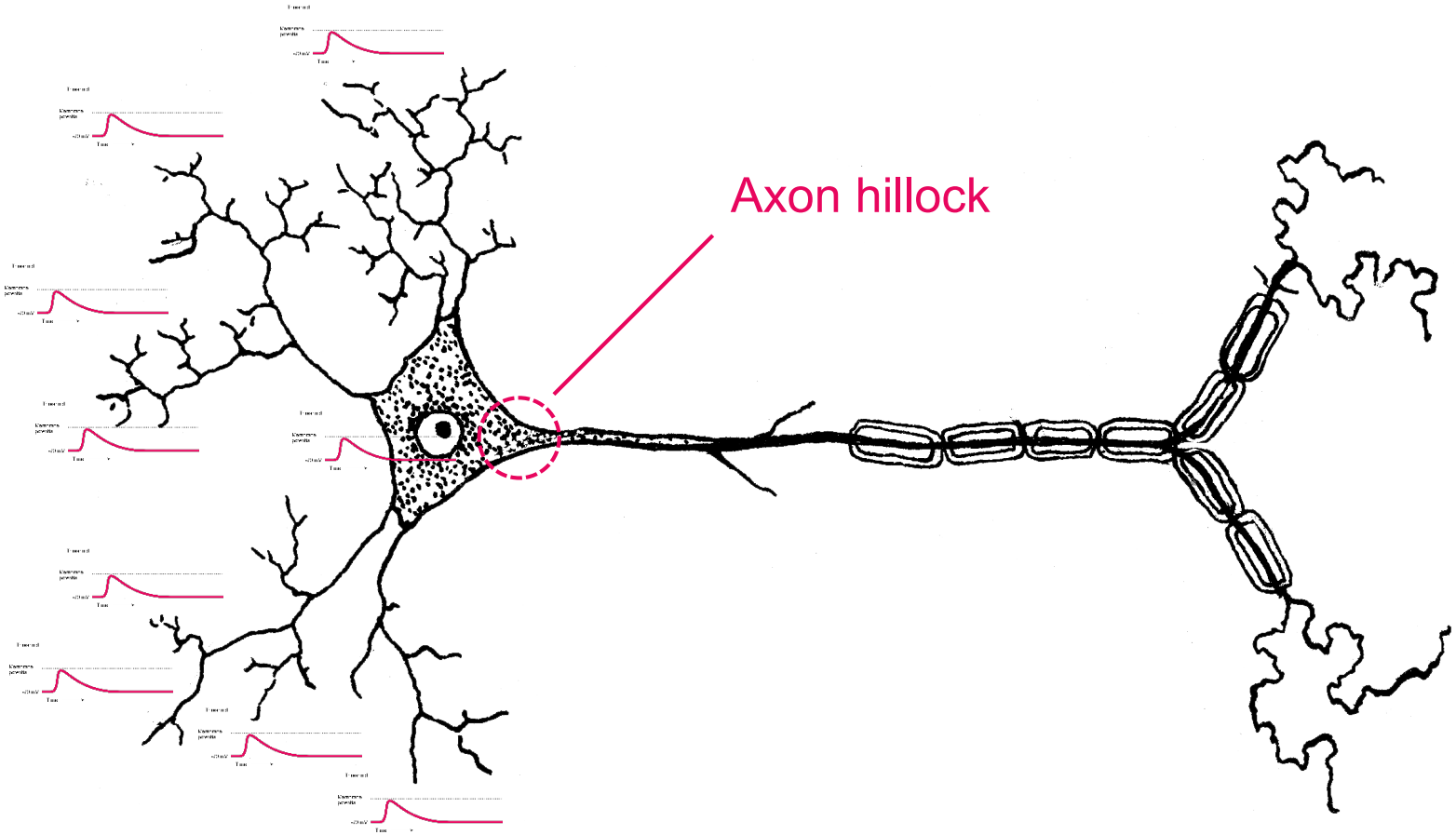
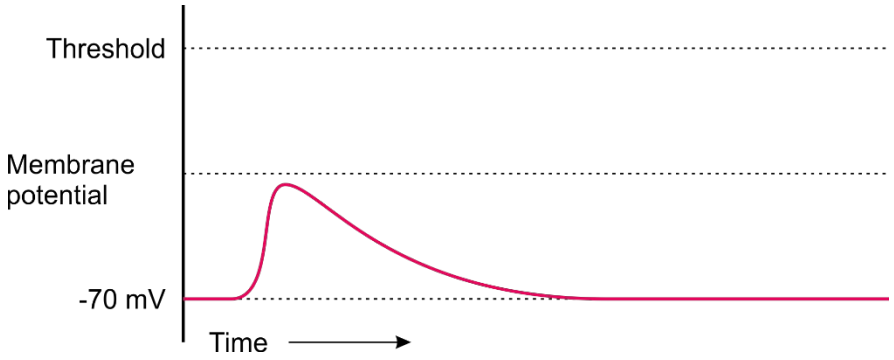
Spatial summation

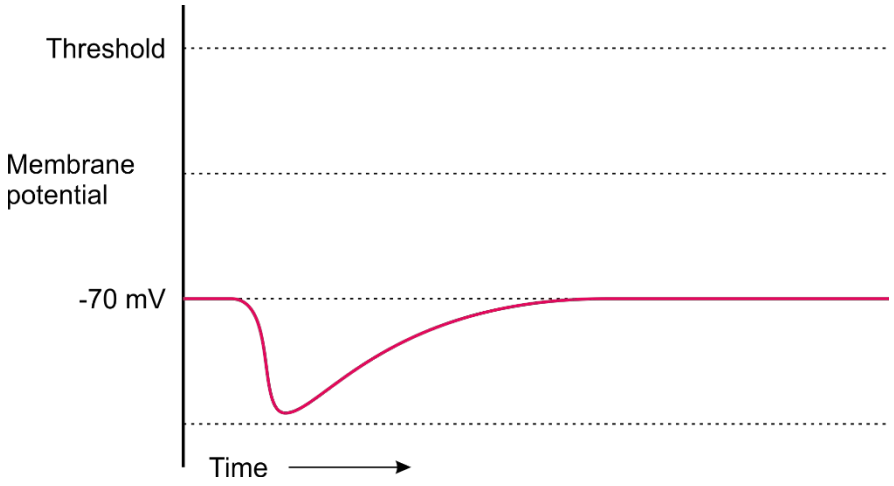


Excitation and inhibition

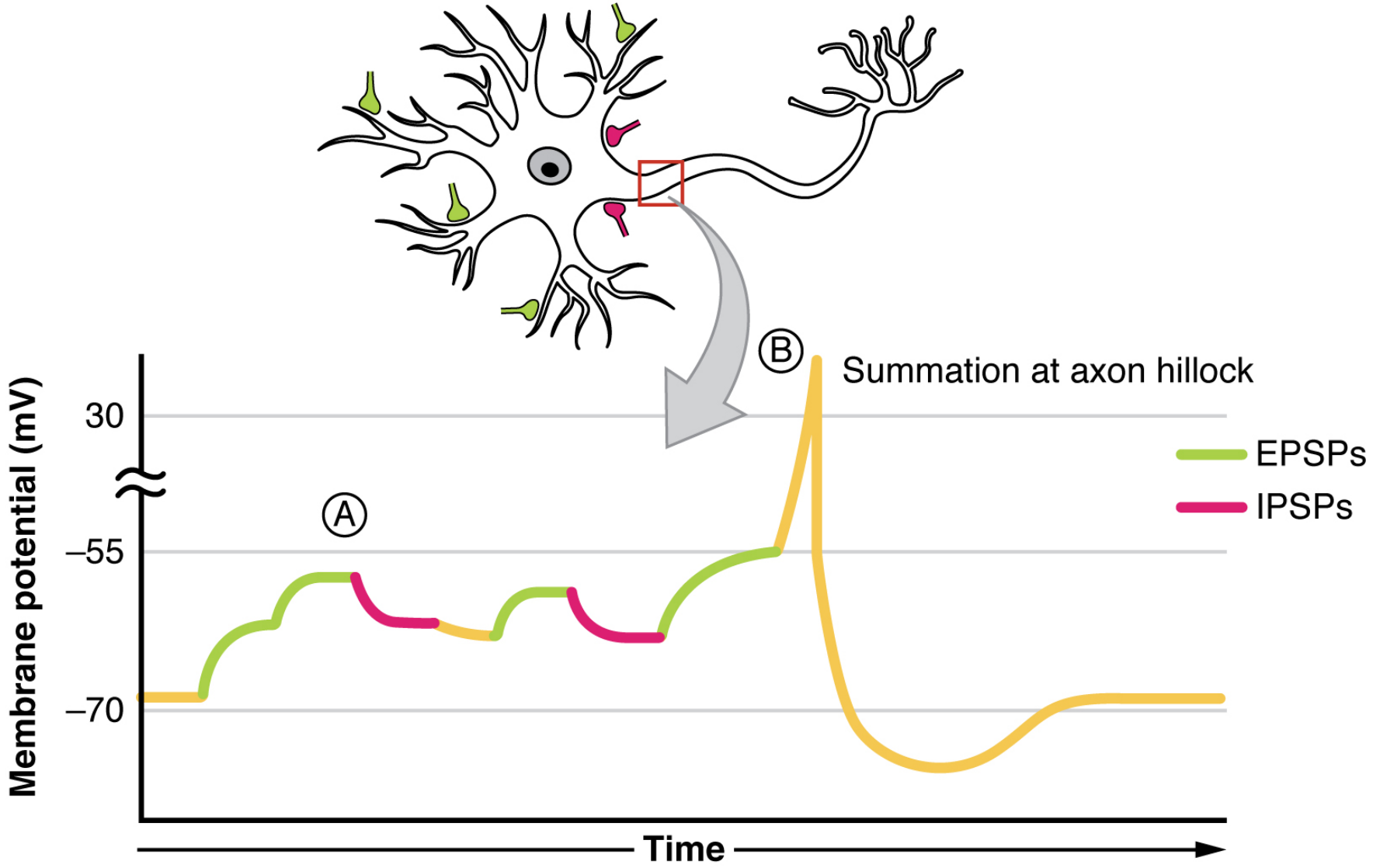
Excitatory post-synaptic potential (EPSP)



Inhibitory post-synaptic potential (IPSP)



Signal integration



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Signal integration

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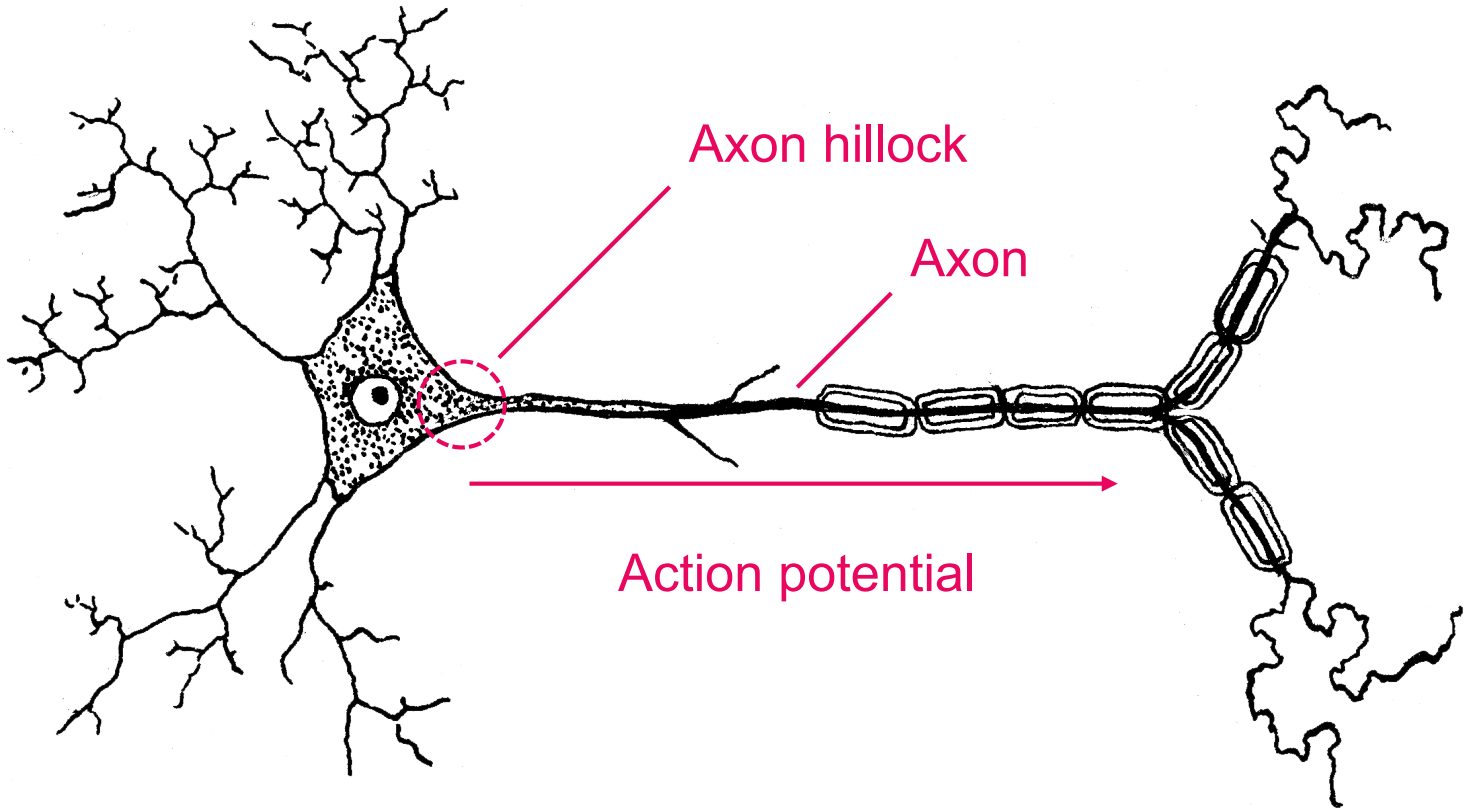
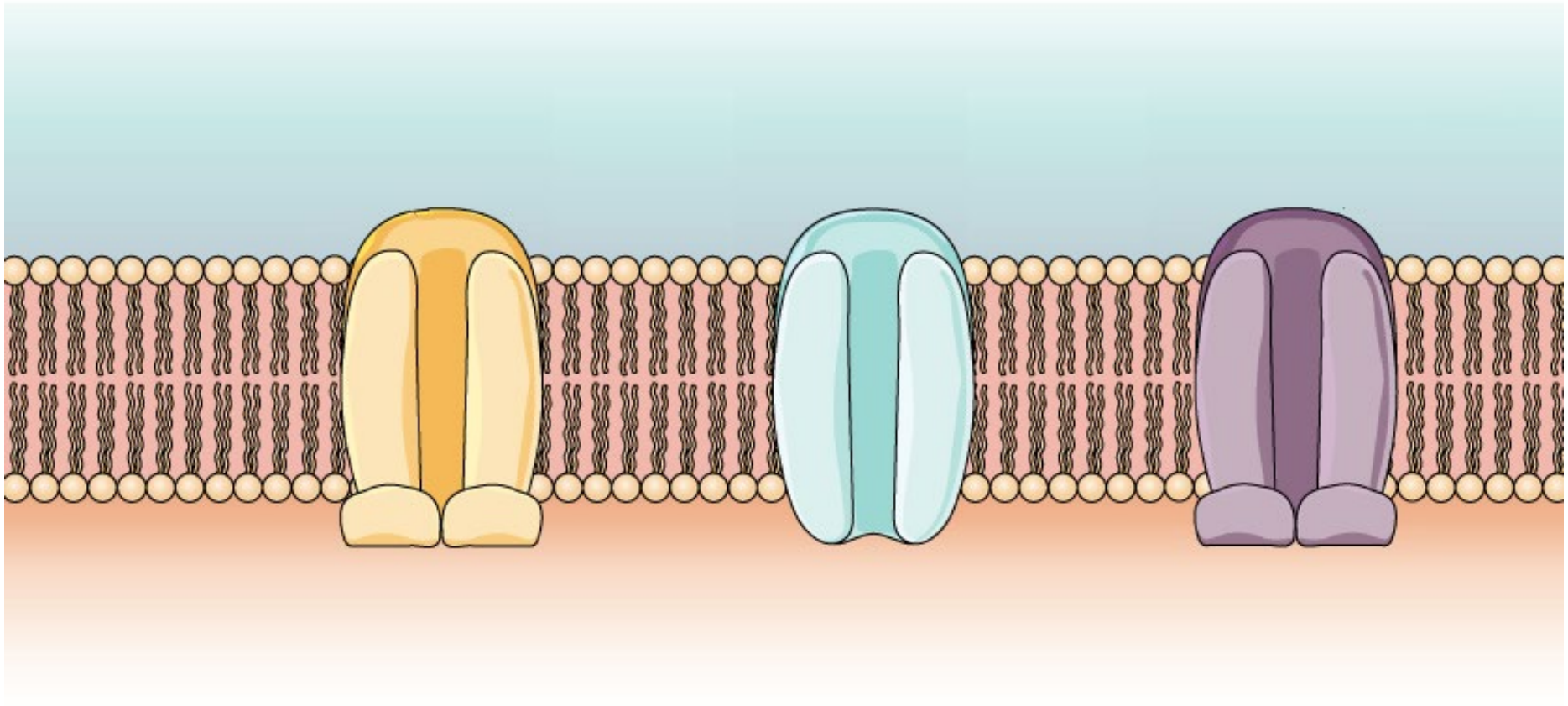
Action potential



Voltage-gated ion channels



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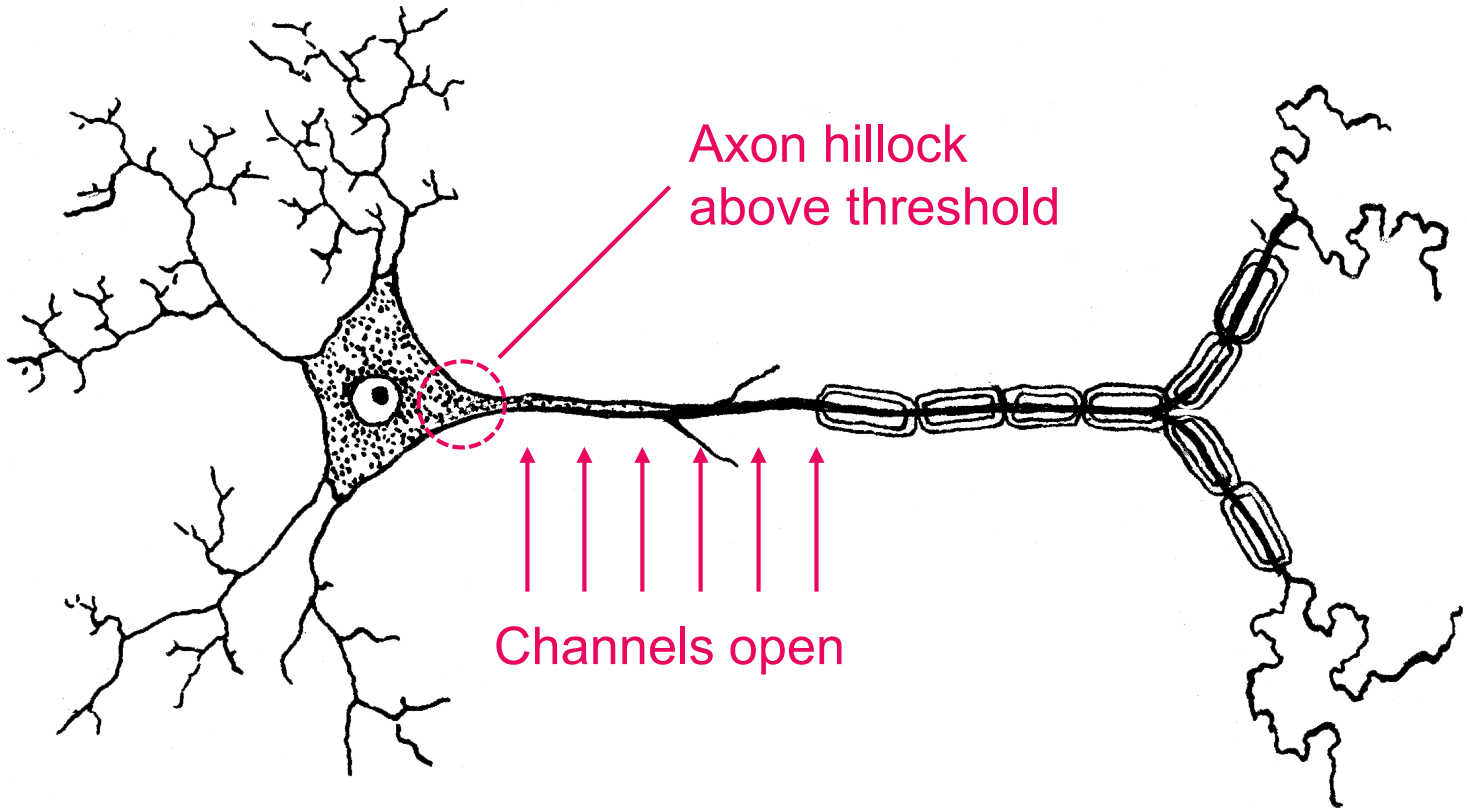
Voltage-gated ion channels

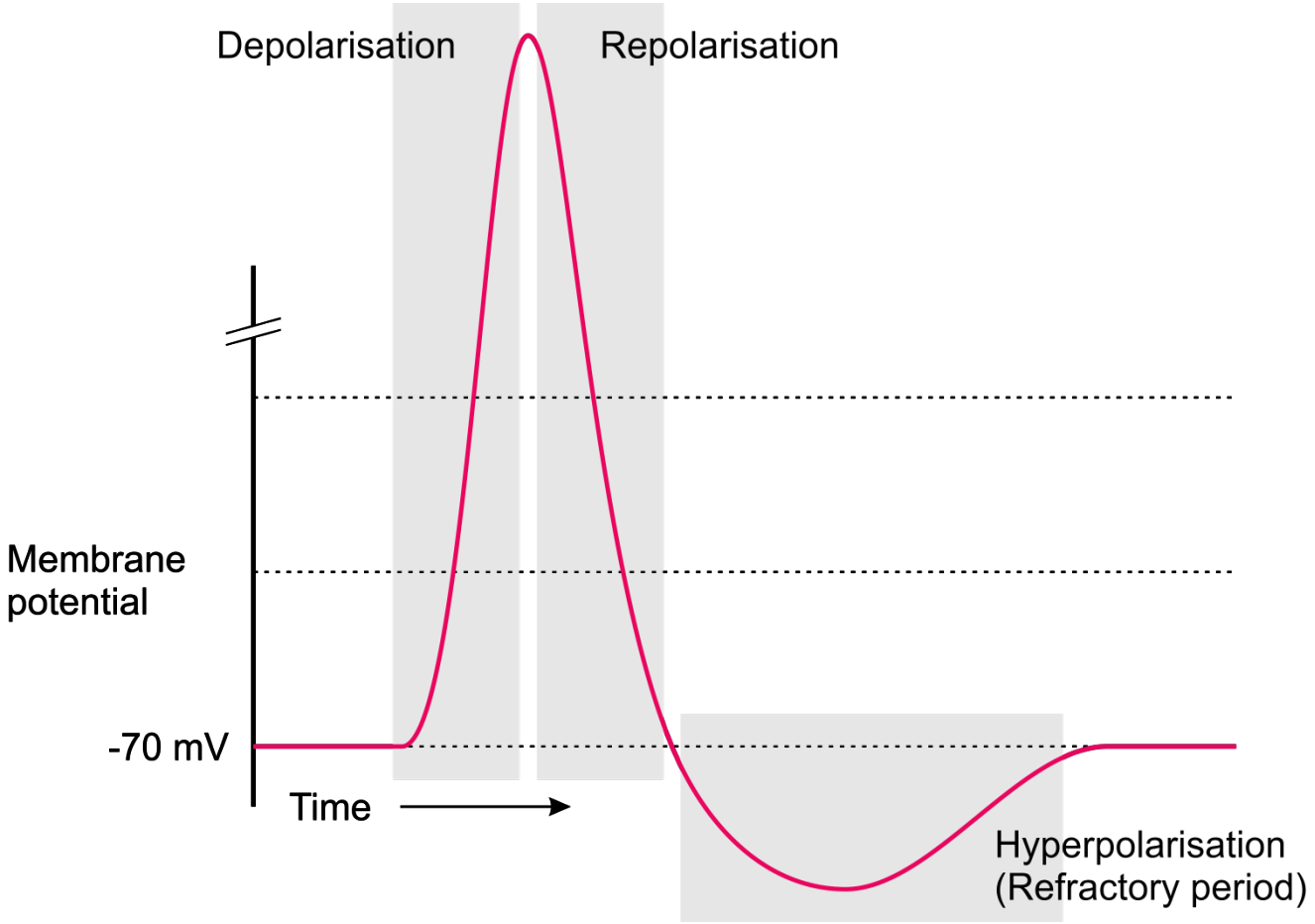
Voltage-gated ion channels are closed when the membrane potential is near its resting potential (-70 mV).

They open when this potential increases to a certain threshold.

Propagation



Action potential



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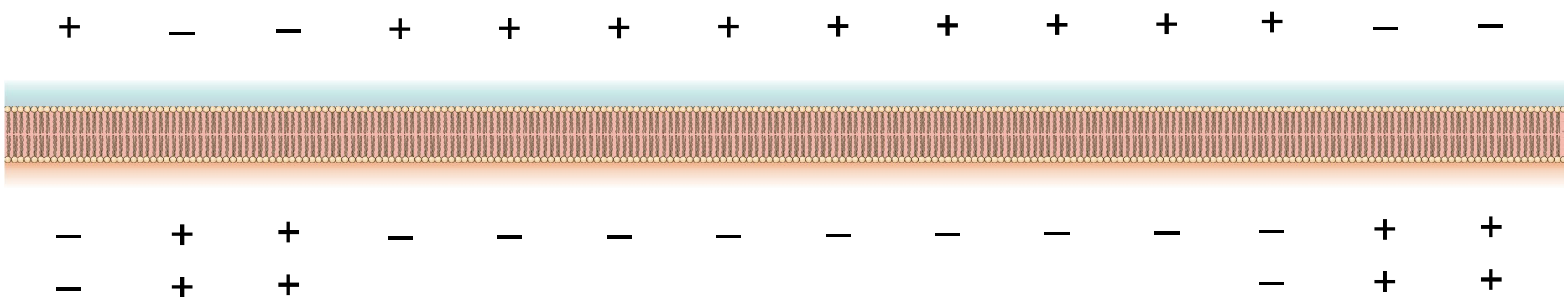
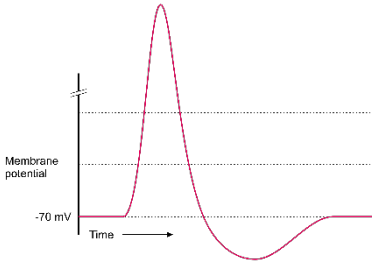
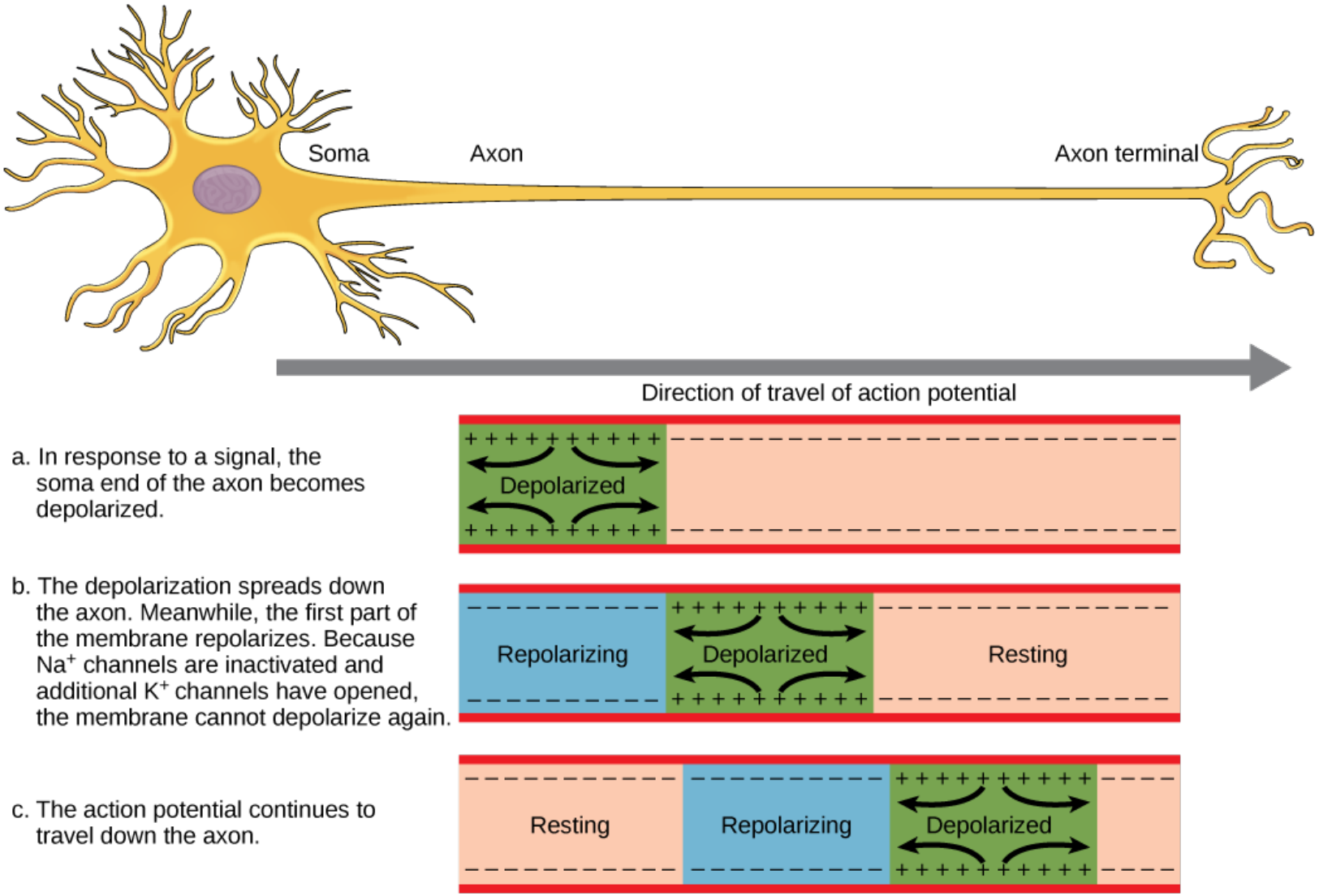
Action potential





Membrane figure from OpenStax is licensed under CC BY 4.0 / Kept only and repeated membrane

Action potential



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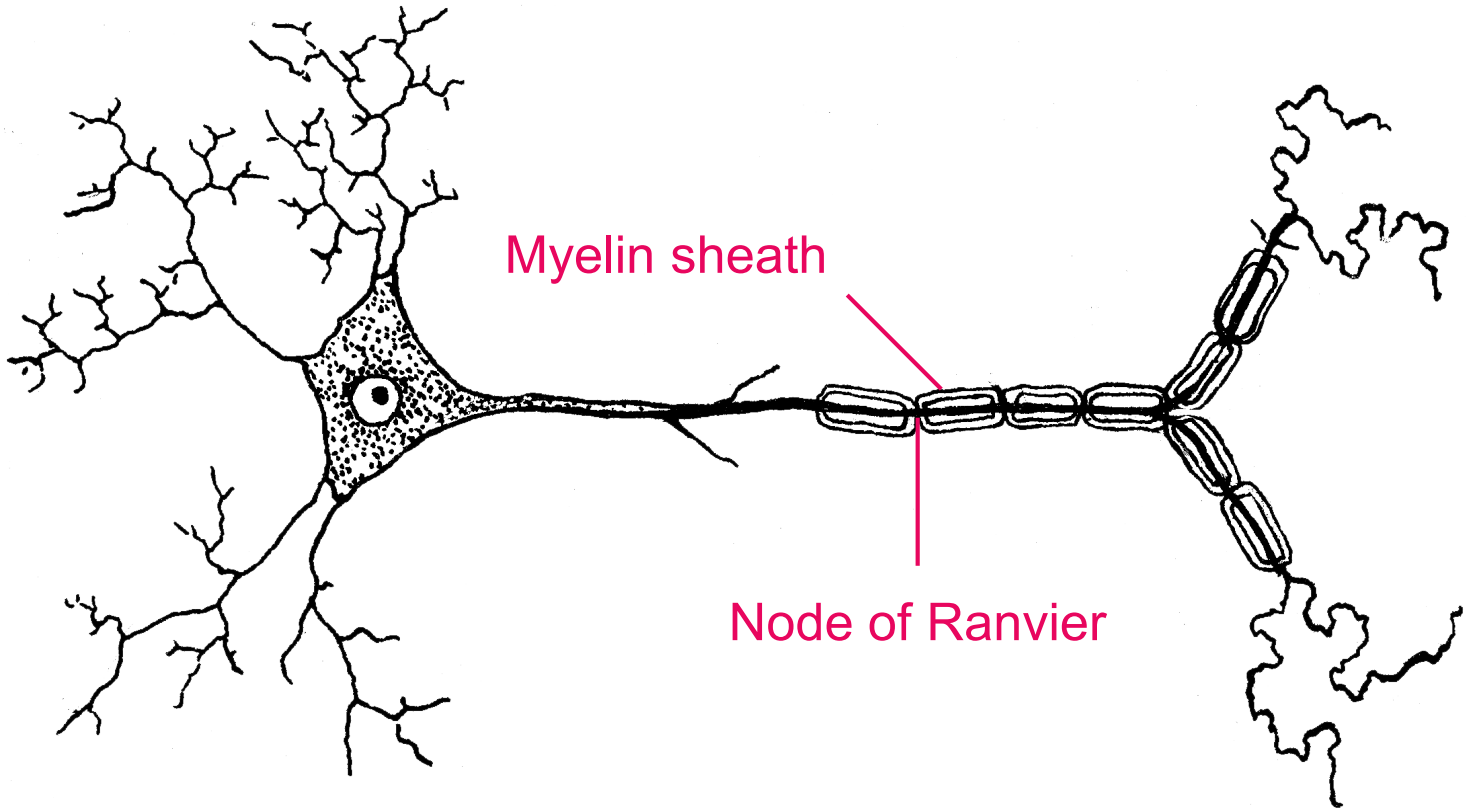
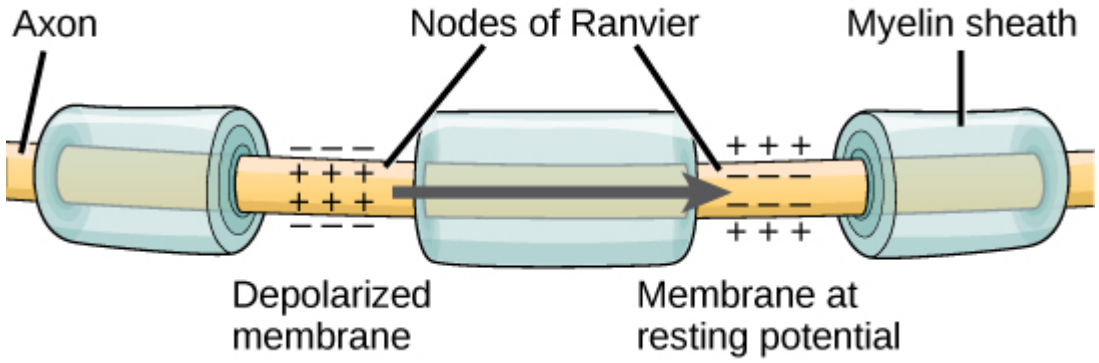
Saltatory conduction



Saltatory conduction



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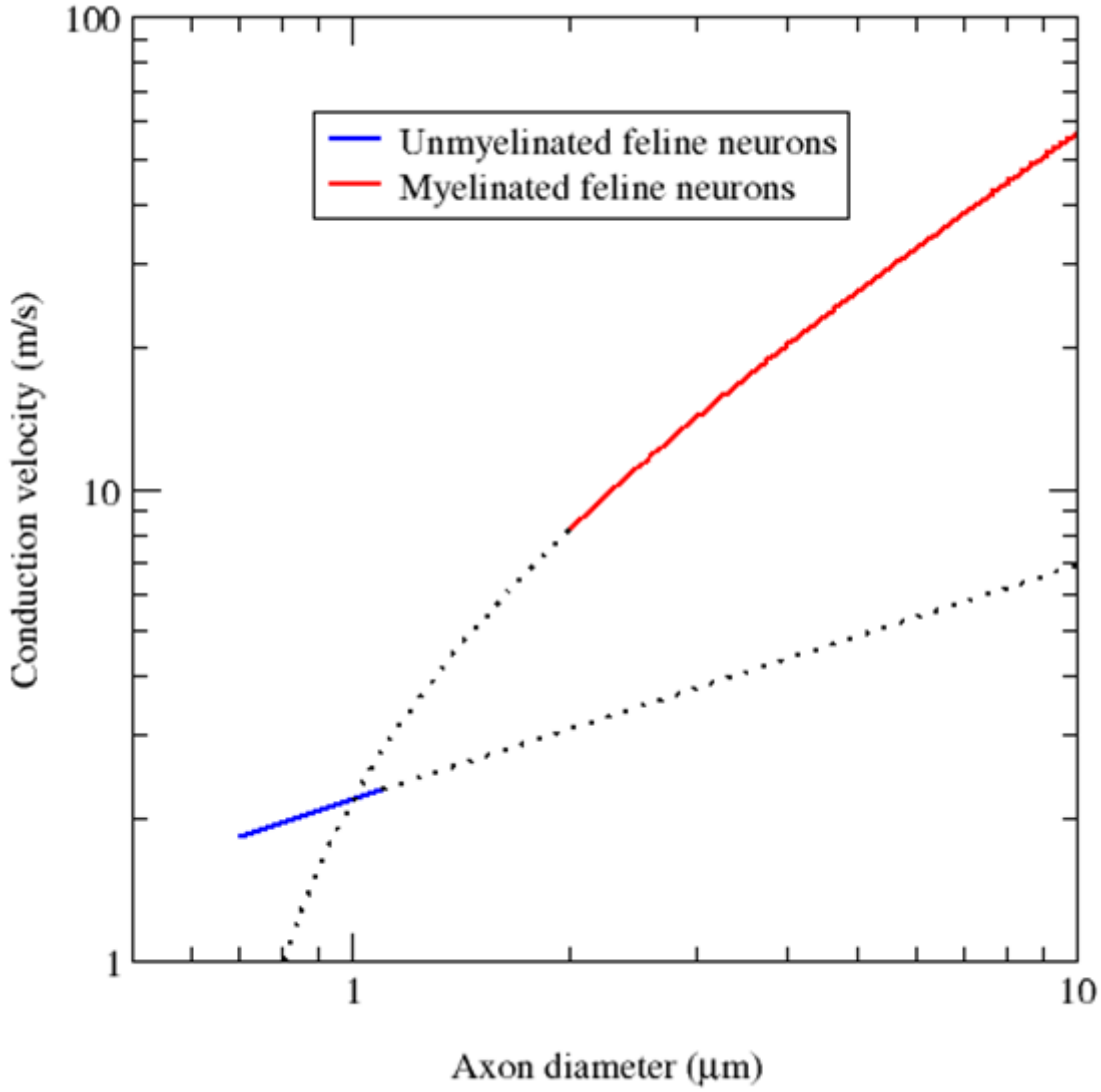
Saltatory conduction

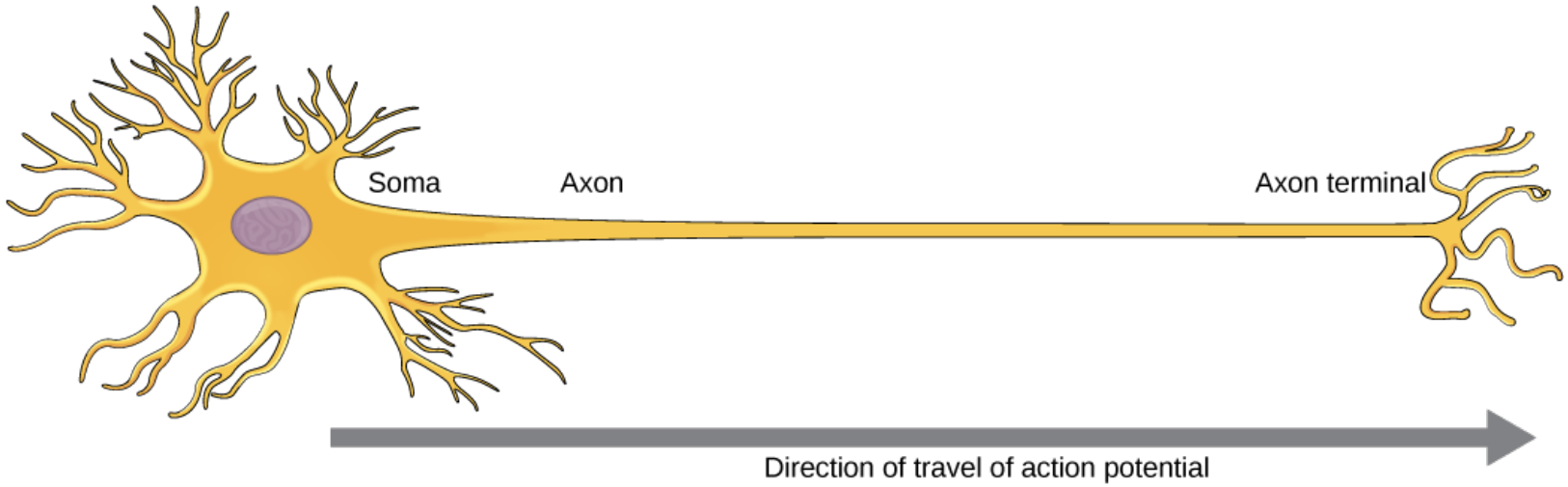


"Conduction velocity and myelination" by WillowW is licensed under CC BY 3.0

Saltatory conduction

Photo: Clay Banks on Unsplash

Action potential



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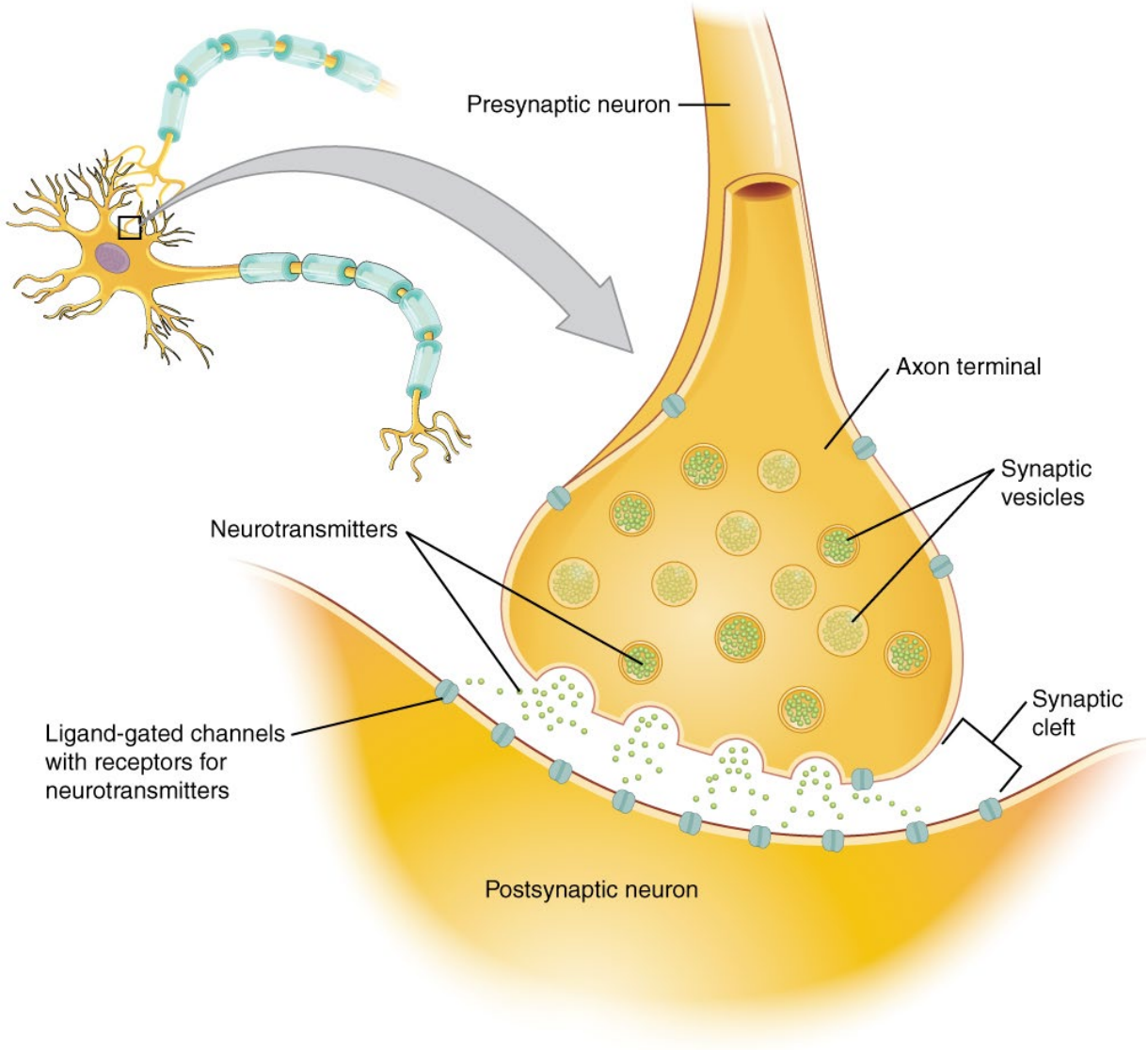
Back at the synapse



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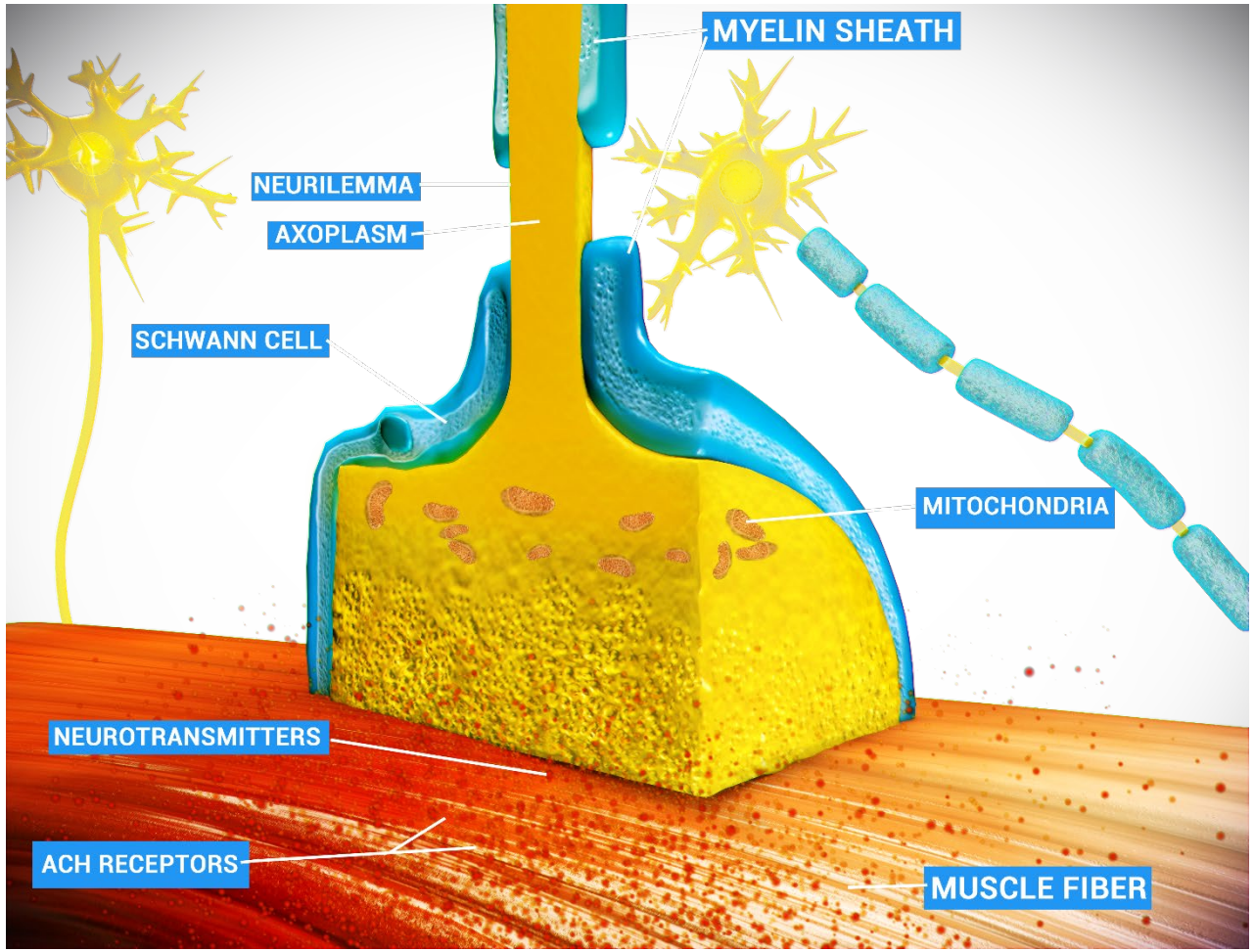
Neuromuscular junction



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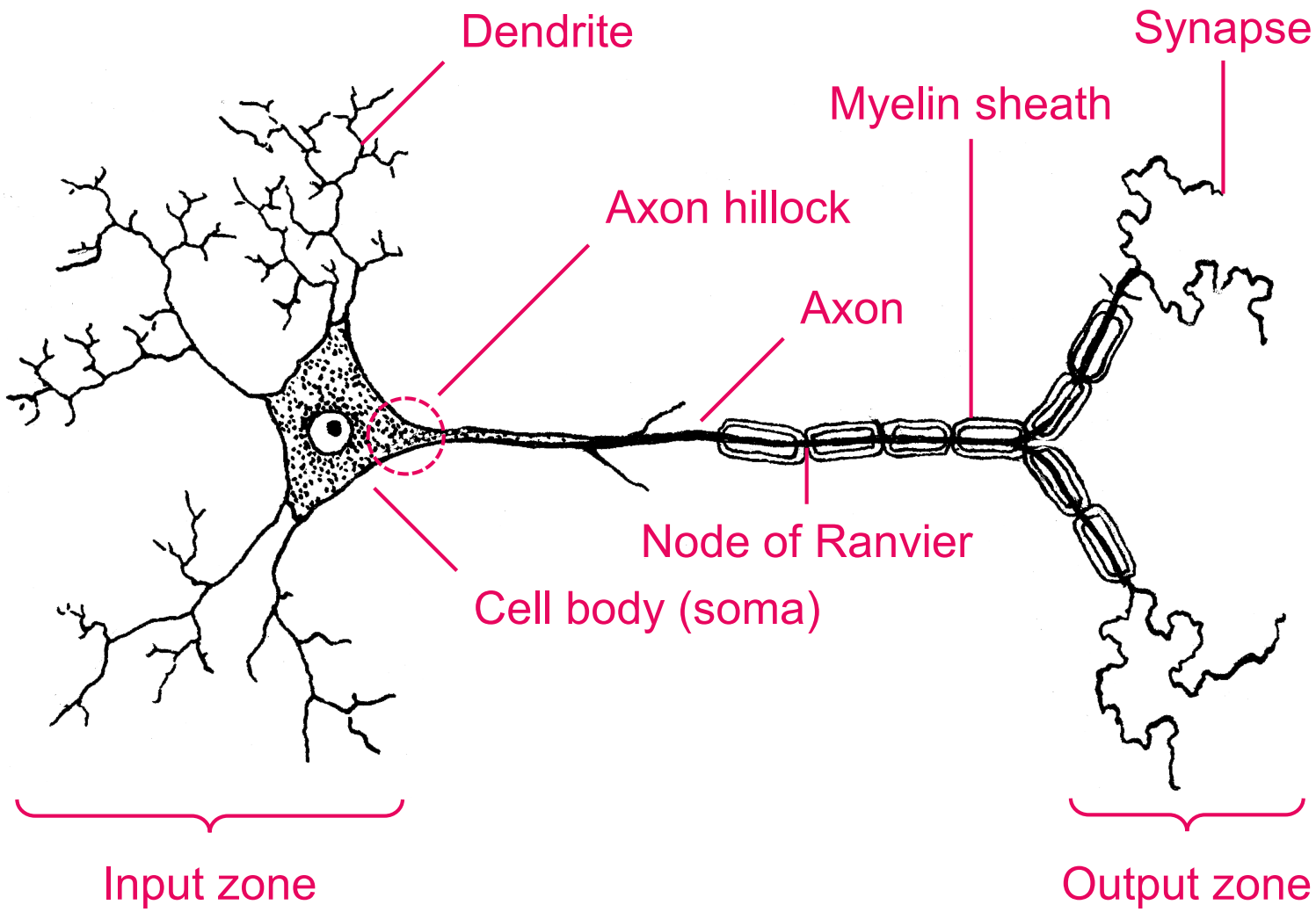
Summary


Dendrite
Synapse
Myelin sheath
Axon hillock
Axon
Node of Ranvier
Cell body (soma)
Input zone
Output zone

Psychophysiology
Part 2.2: Neurons and neuronal transmission

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