

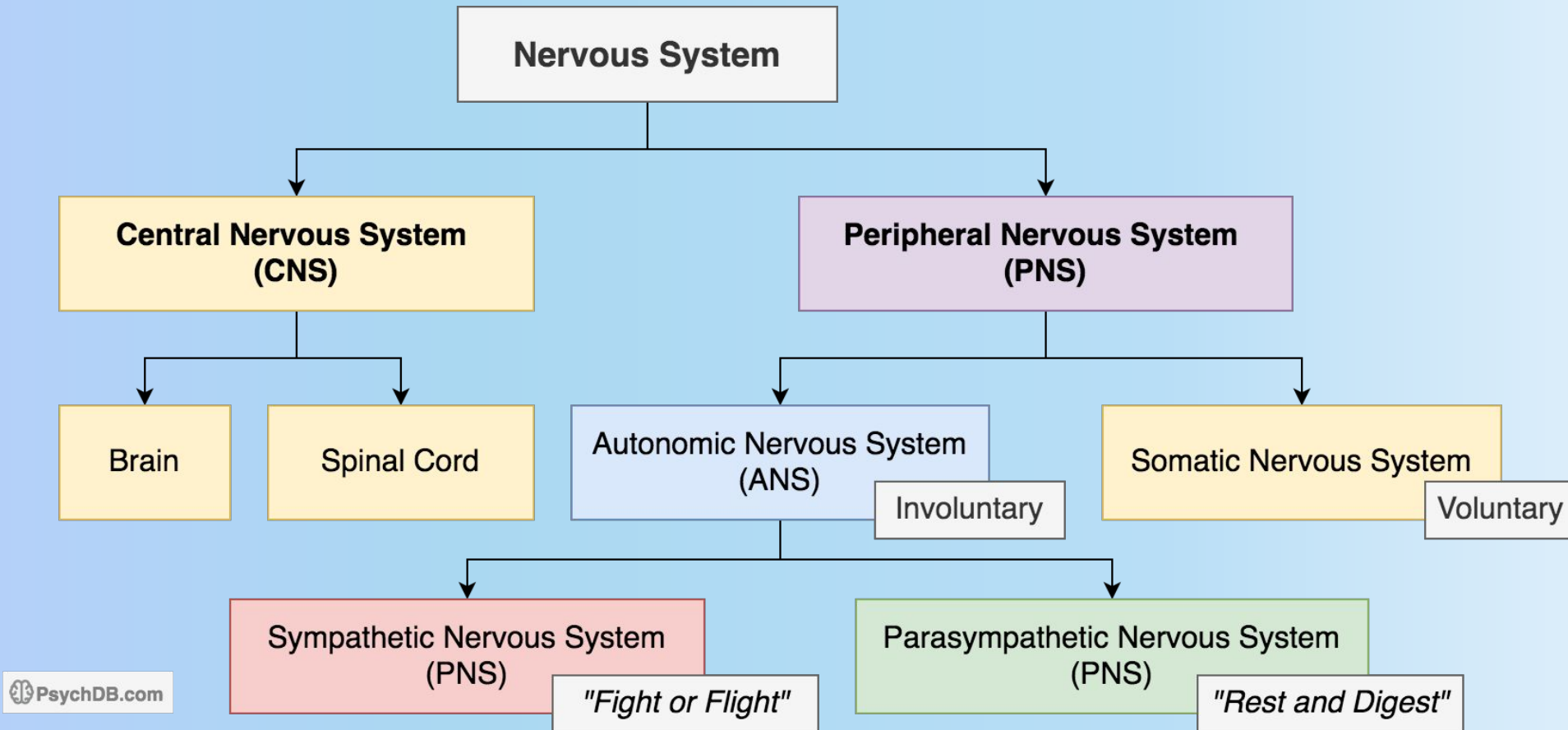
Sympathetic & Parasympathetic Nervous System

Melissa Cartwright

Overview

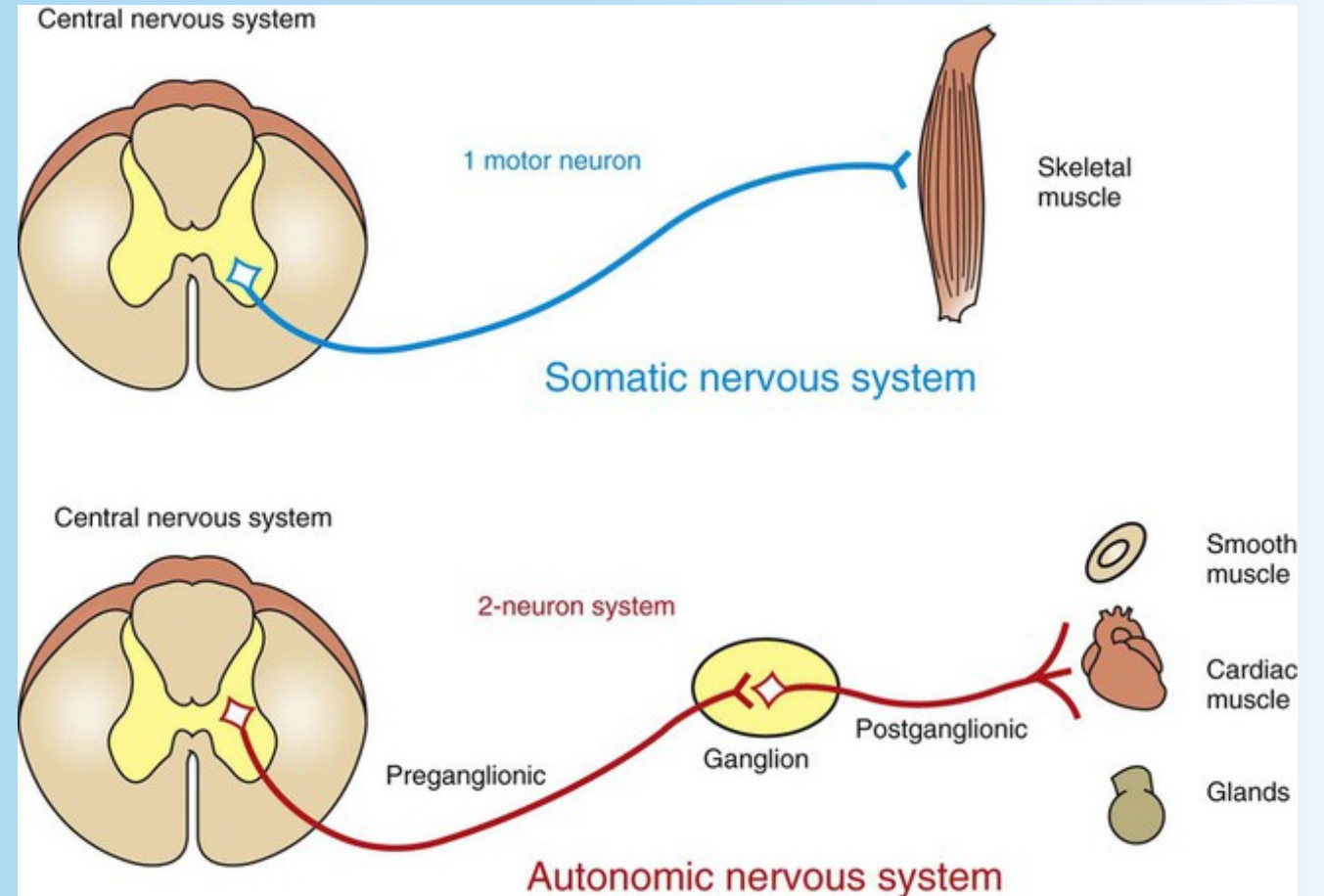
- Nervous System Organization
- Autonomic Nervous System
- Parasympathetic vs. Sympathetic
- Parasympathetic Nervous System
- Sympathetic Nervous System
- Action Potential
- Wooclap

Organization of the Nervous System



Autonomic Nervous System

- Autonomic NS uses 2 neurons, whereas Somatic NS uses 1 neuron
- **Preganglionic Neuron:** Delivers information from CNS to Ganglion
- **Postganglionic Neuron:** Delivers information from ganglion to visceral effector organs



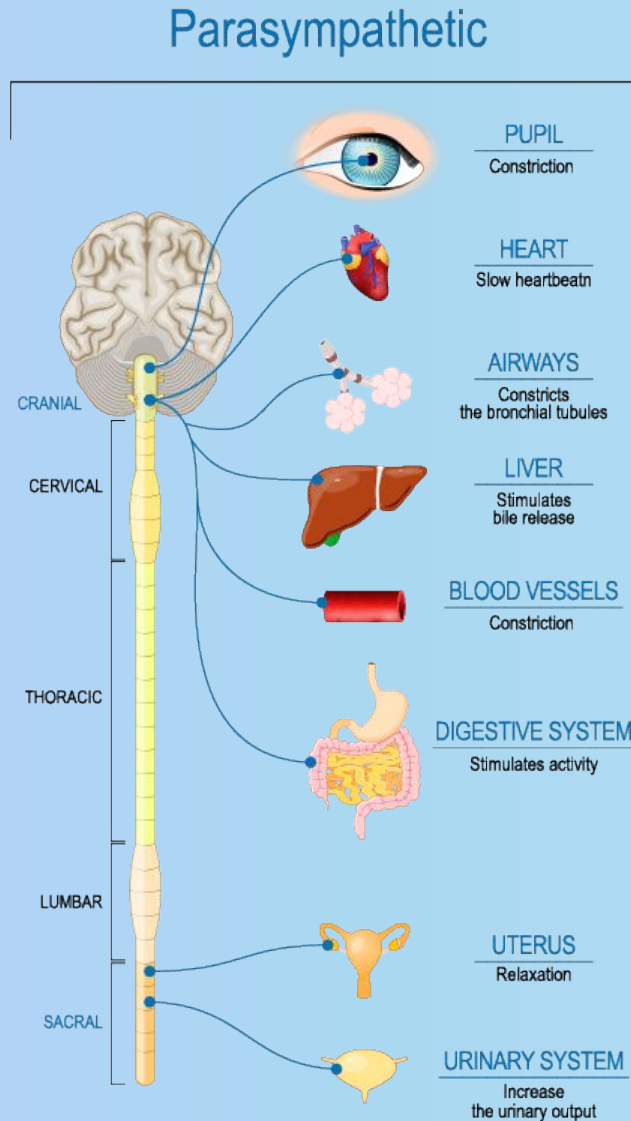
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Parasympathetic vs Sympathetic

“Rest and Digest”

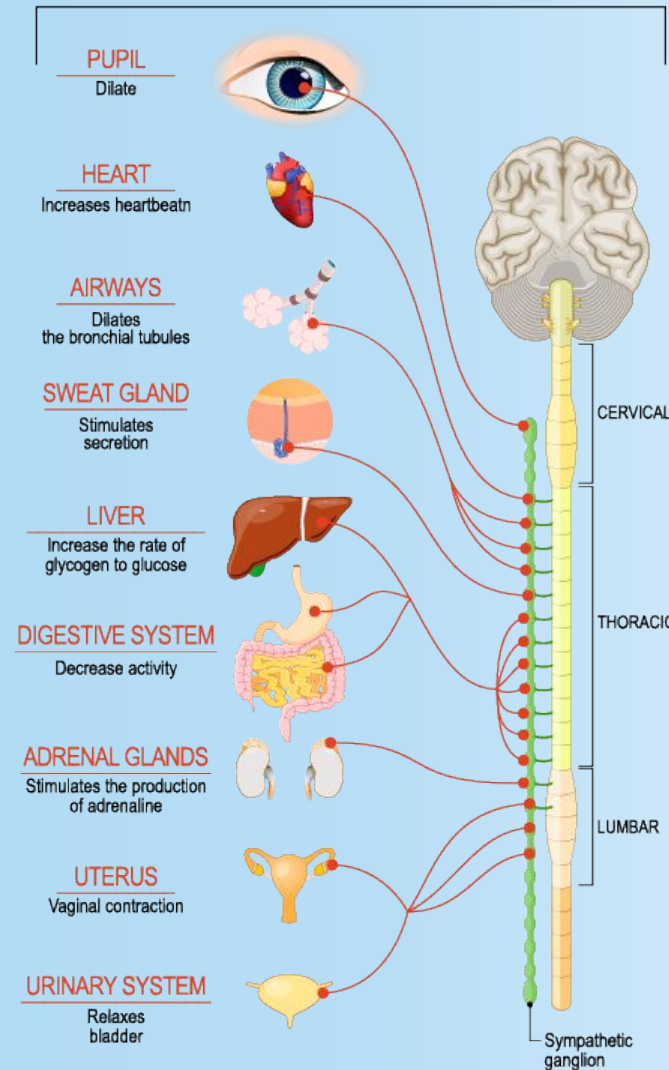
Allows the body to rest and regenerate



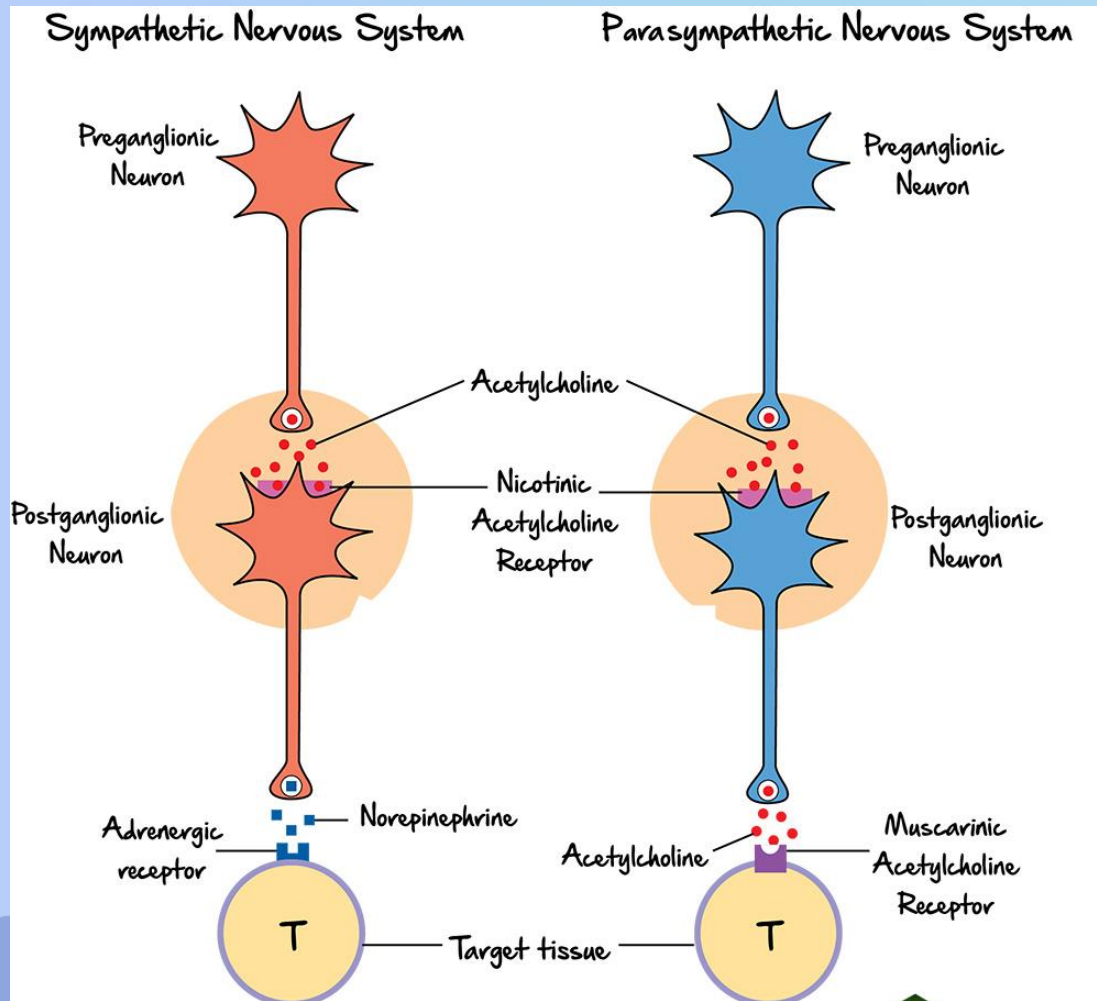
Sympathetic

“Fight or Flight”

Helps mobilize the body for movement



Parasympathetic vs Sympathetic

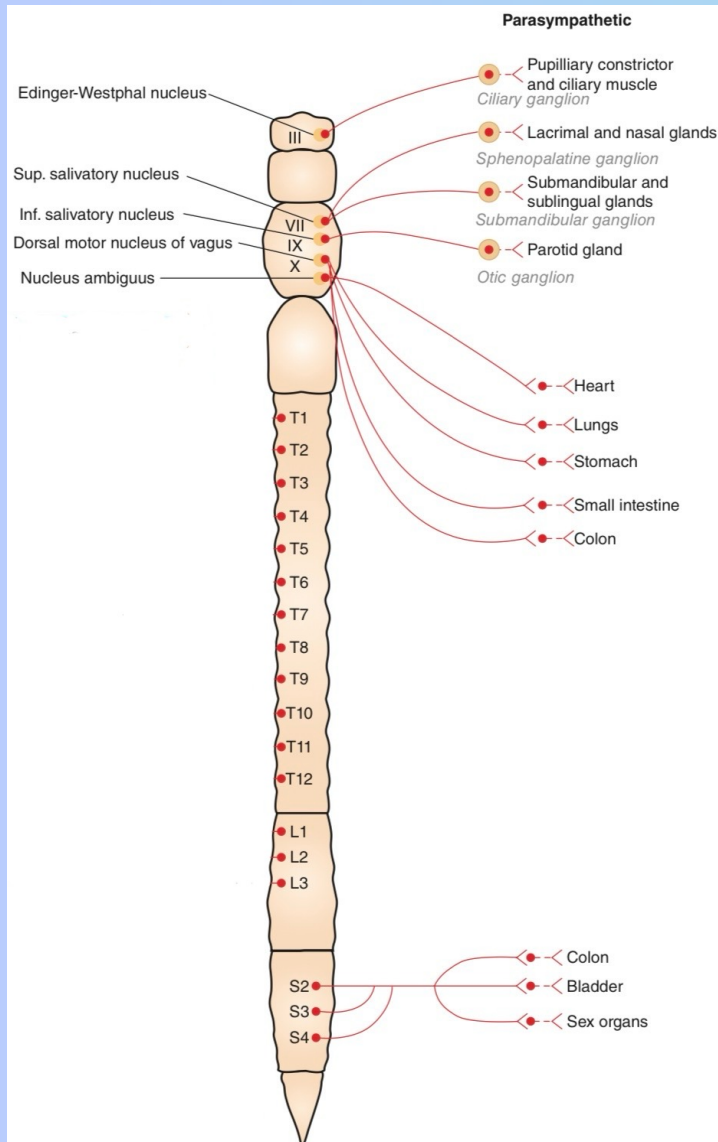


- Parasympathetic
 - Both Pre and Postganglionic neurons use **Acetylcholine** (Cholinergic)
- Sympathetic
 - Preganglionic neuron uses **Acetylcholine** (Cholinergic)
 - Postganglionic neuron uses **Norepinephrine** (Adrenergic)

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Parasympathetic NS

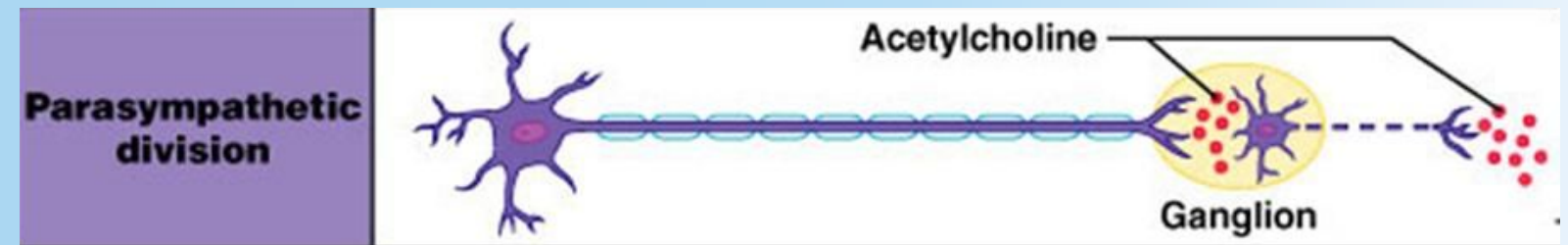


Preganglionic

- **Craniosacral:** Fibres arise from nuclei of the cranial nerves (3,7,9 and 10) or sacral spinal cord (S2-S4) and synapse on ganglia
- Use Acetylcholine

Postganglionic

- Carry information from ganglia a short distance to target organ
- Use Acetylcholine

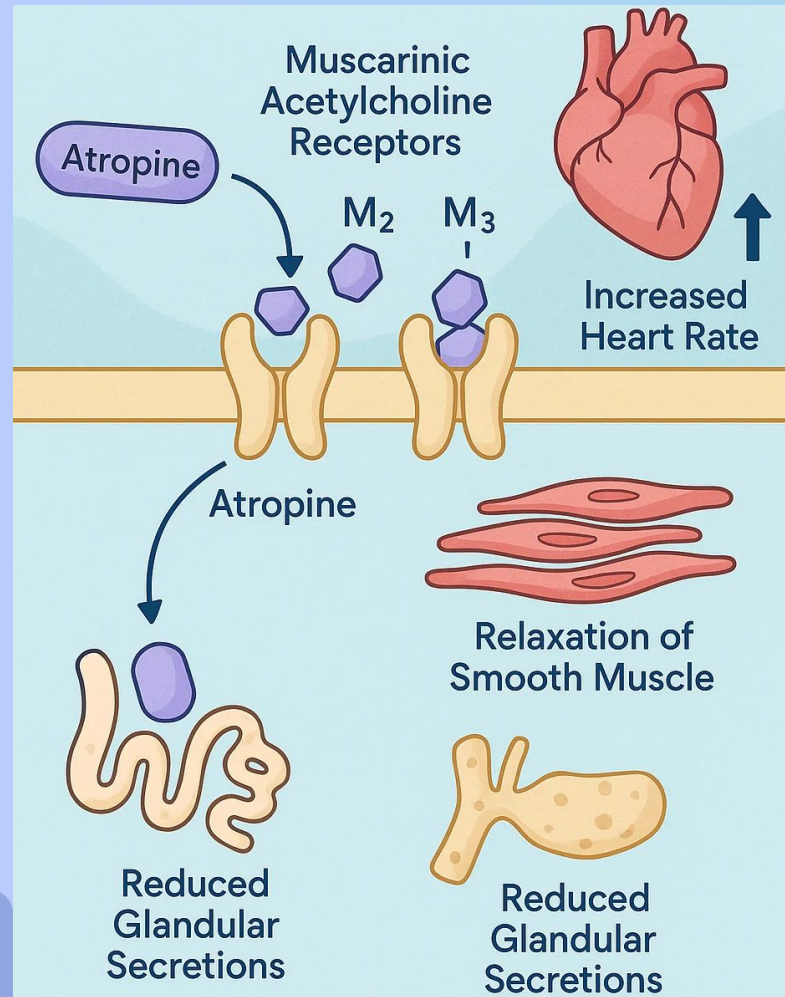


Parasympathetic NS

EFFECTOR	PARASYMPATHETIC NERVOUS SYSTEM	
	RECEPTOR	EFFECT
PUPILS	M ₃	Constriction
HEART	M ₂	Decreases Heart Rate and AV node conduction velocity
LUNGS	M ₃	Bronchoconstriction, ↑ gland secretion
GI TRACT	M ₃	↑ motility, sphincter relaxation, ↑ gland secretion
URINARY TRACT	M ₃	Bladder sphincter relaxation
SKELETAL MUSCLE	-	None
SKIN	-	None
GLANDS	M ₁ , M ₃	↑ salivation, ↑ lacrimation, ↑ pancreatic activity

- The parasympathetic NS system uses Acetylcholine to act on Muscarinic receptors in target tissues
- M2 receptors: Decrease HR and Conduction speed (AV node)
- M3 receptors: In the lungs, increased bronchoconstriction and gland secretion

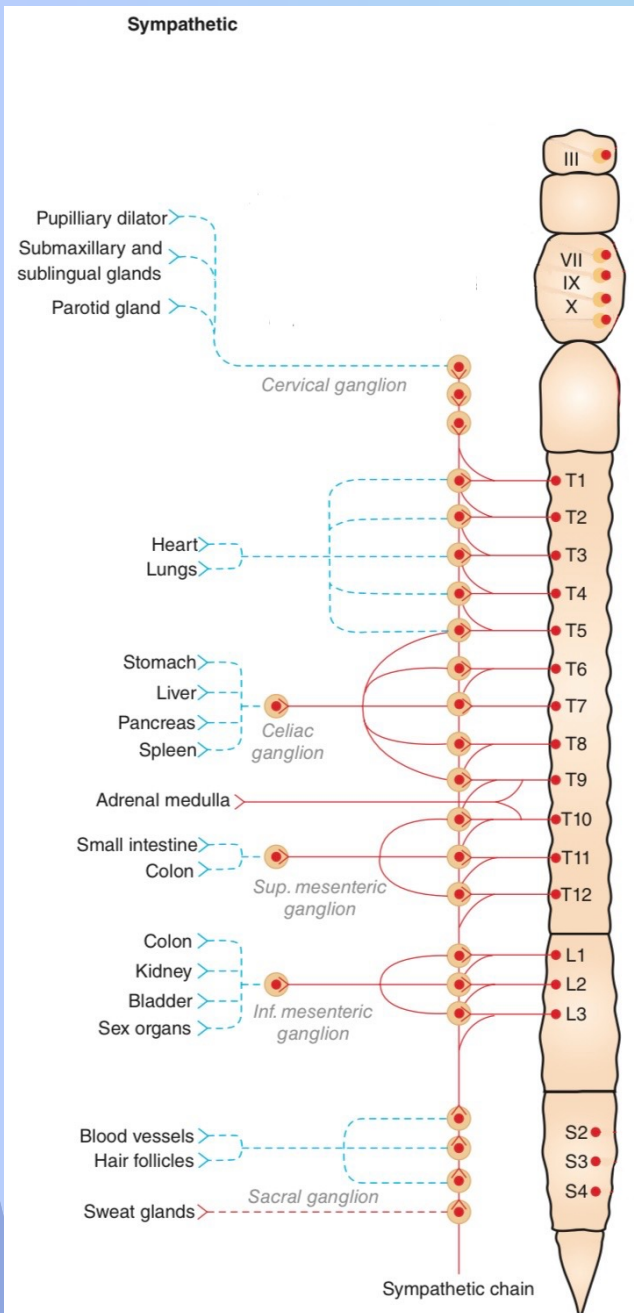
Clinical Correlation



- Atropine
 - Inhibits M₁, M₂ and M₃ receptors
 - Used before intubation, to suppress the Vagus (X) nerve
 - Used for some ophthalmological procedures to dilate the pupil

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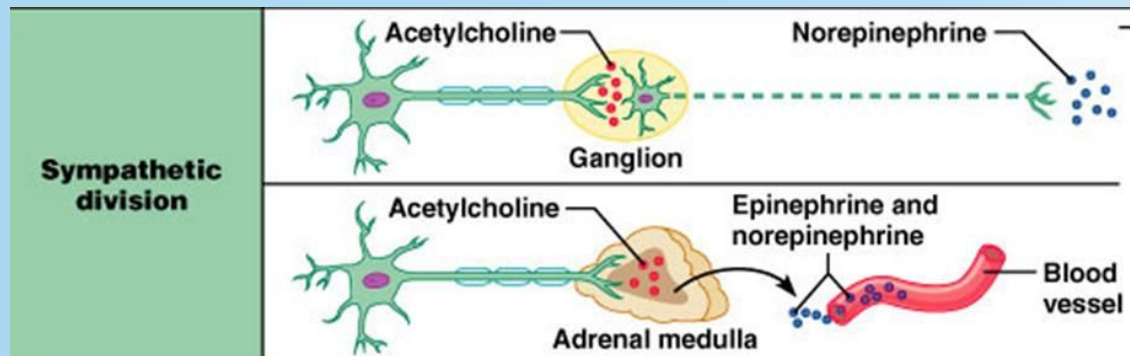
Sympathetic NS

Preganglionic

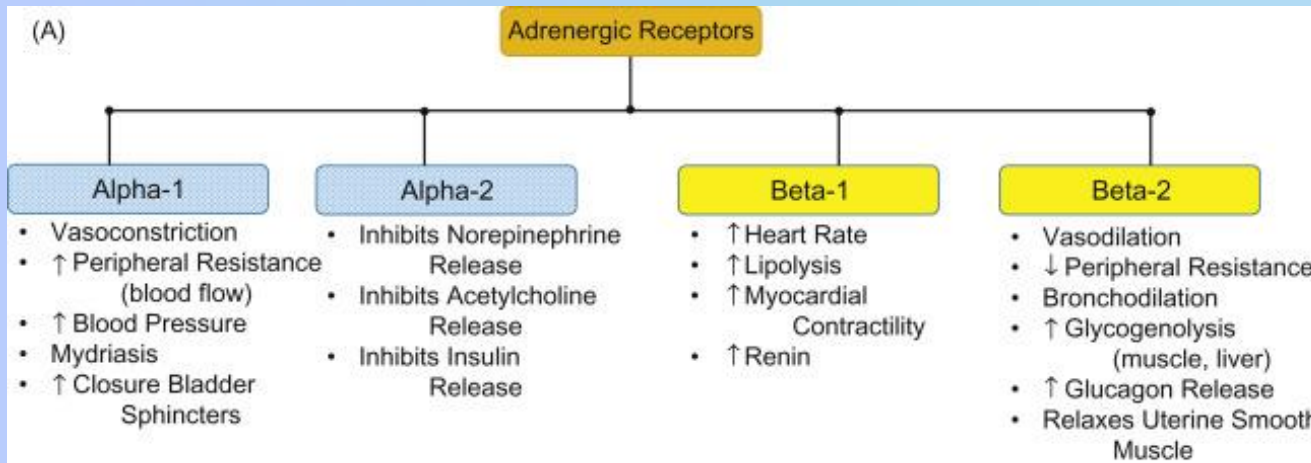
- Thoracolumbar, fibres arise from thoracic and lumbar spinal cord and synapse onto sympathetic chain or ganglia
- Acetylcholine

Postganglionic

- Carry information from sympathetic chain (or ganglia) to target organs
- Noradrenaline



Adrenergic Receptors



- Alpha 1
 - Blood vessels: **Smooth muscle** (constriction)
- Alpha 2
 - Nerve terminals: Negative feedback
- Beta 1
 - Acts on the **heart** primarily
- Beta 2
 - **Bronchi** (dilation)
 - Blood vessels: **Skeletal Muscle** (dilation)

Adrenergic Receptors

EFFECTOR	SYMPATHETIC NERVOUS SYSTEM	
	RECEPTOR	EFFECT
PUPILS	α_1	Dilation
HEART	β_1	Increases Heart Rate and Contractility
LUNGS	β_2	Bronchodilation
GI TRACT	α_1	Vasoconstriction, sphincter contraction
URINARY TRACT	α_1, β_1	Bladder sphincter contraction, \uparrow renin secretion
SKELETAL MUSCLE	β_2	Vasodilatation
SKIN	α_1	Vasoconstriction
GLANDS	α_1	\uparrow sweating, \downarrow pancreatic activity

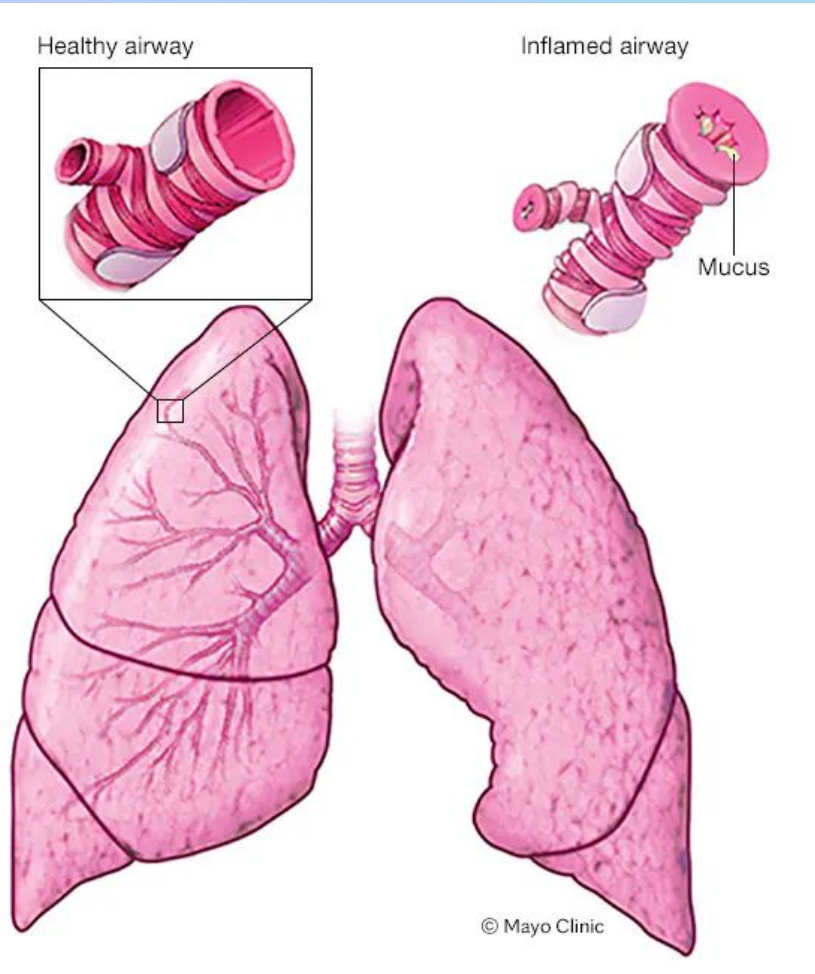
Clinical Correlation

- Cocaine



- Blocks the Noradrenaline transporter at sympathetic nerve endings
- Noradrenaline to builds up in the synapse → prolonged stimulation of adrenergic receptors
- Can result in myocardial infarction

Clinical Correlation



- Asthma
 - What happens in Asthma?
 - Walls of the bronchi are hypersensitive to certain triggers, they then constrict, **swell** and **produce excess mucus**
 - **Adrenaline** is administered
 - **Stimulates β_2 receptors** in the lungs
 - **Rapid bronchodilation** and **decreased mucus production**

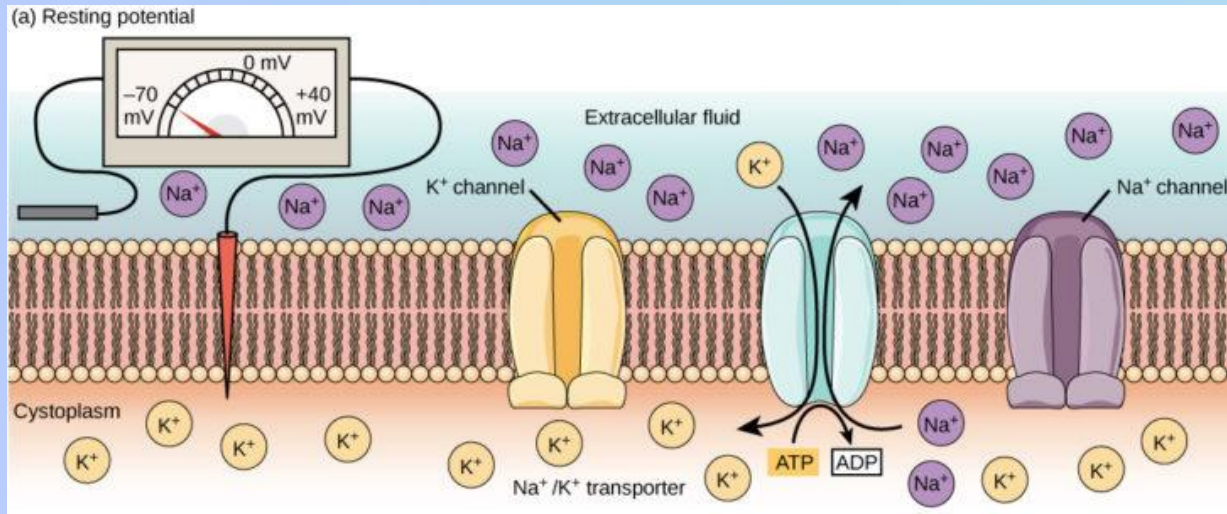
Bringing it all together

Feature	SYMPATHETIC NS	PARASYMPATHETIC NS
Summary of Response	Fight or Flight	Rest and Digest
Spinal Cord Distribution	Thoracolumbar	Craniosacral
Preganglionic Neuron Length	Short	Long
Preganglionic Neurotransmitter	Acetylcholine	Acetylcholine
Preganglionic Receptor	Nicotinic Receptor	Nicotinic Receptor
Postganglionic Neuron length	Long	Short
Postganglionic Neurotransmitter	Noradrenaline	Acetylcholine
Postganglionic Receptor	Muscarinic Receptor (M1, M2, M3)	α 1, α 2, β 1, β 2

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Resting Membrane Potential



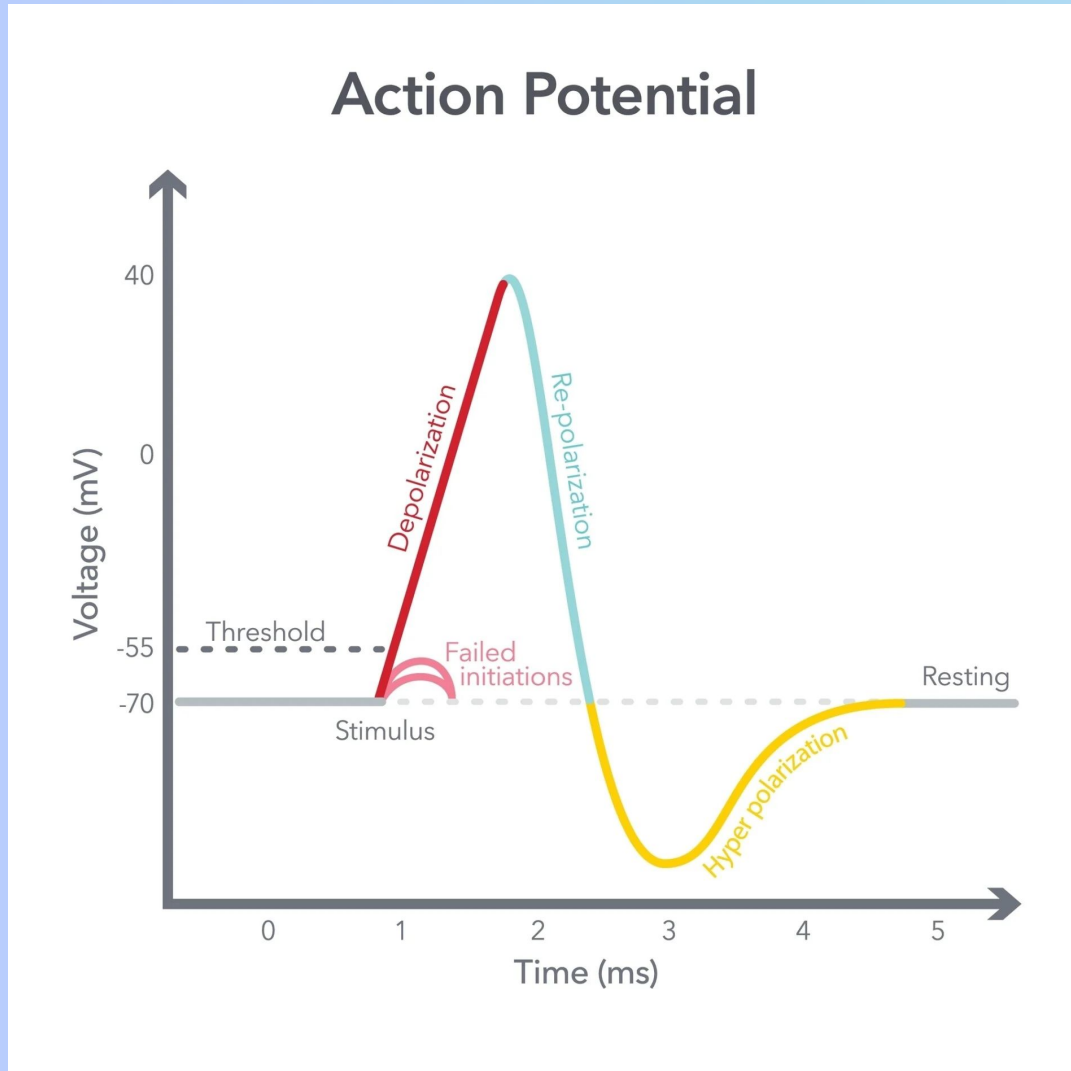
In neurons resting membrane potential is -70 mV. Why?

- Different permeability to ions, more K⁺ leak channels than Na⁺ or Cl⁻
- Na⁺/-K⁺ ATPase: 3 Na⁺ out for every 2 K⁺ in

What is Membrane Potential ?

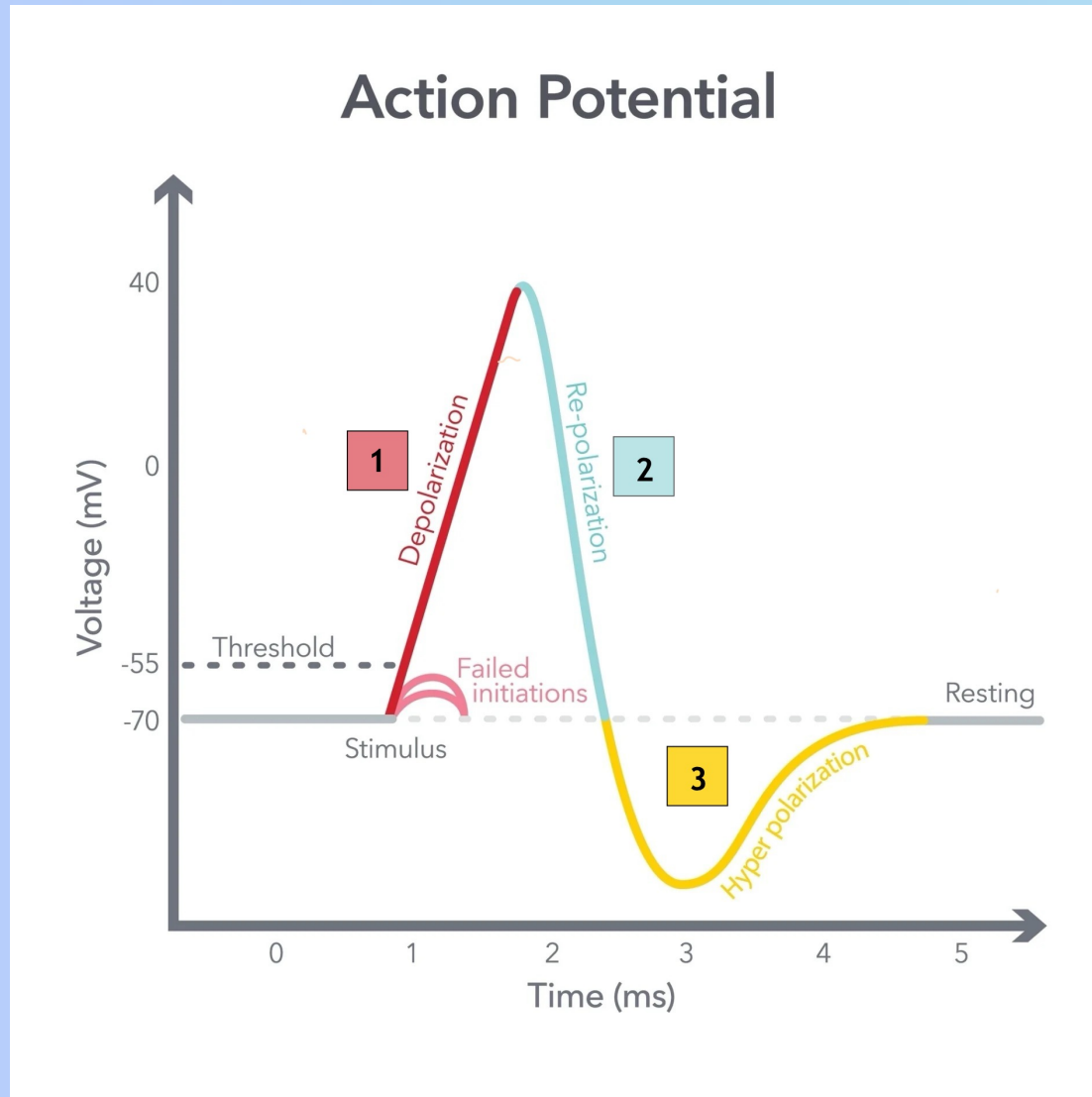
Relative charge intracellularly compared to extracellularly

Threshold



- Neurons constantly receive input from the environment, but not all input will result in an action potential
- “All or nothing”: Only if the membrane potential passes -55mV (threshold) will there be an action potential

Depolarization



- Threshold is surpassed → Depolarization begins
 - Voltage gated Na^+ channels open and there is **Na^+ influx**

Repolarization



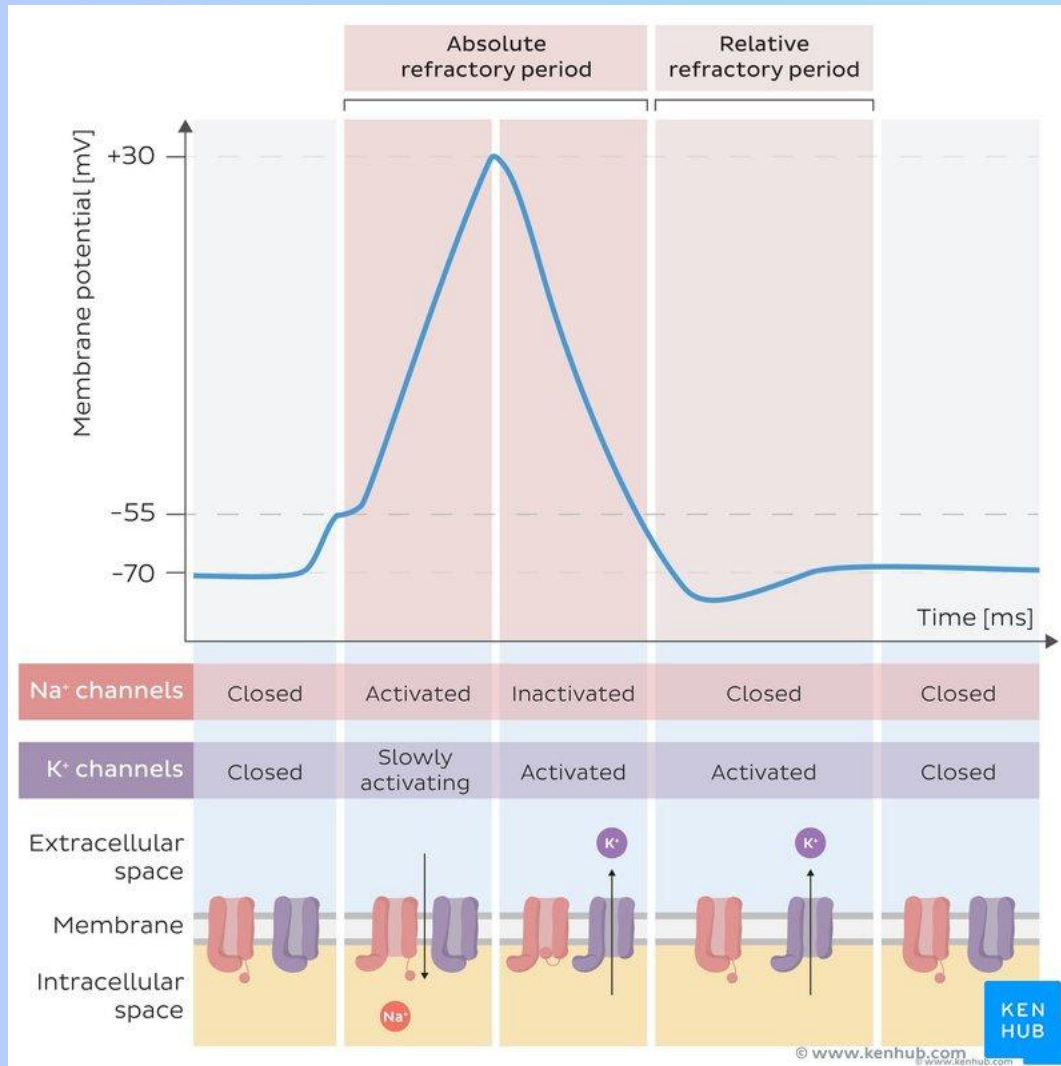
- Membrane potential **surpasses +30 mV**
 - Voltage gated Na^+ channels are inactivated, meaning **no more Na^+ can enter**
- At the same time voltage gated K^+ channels open resulting in an **outflow of K^+**

Hyperpolarization



- Membrane potential is too negative now
 - Voltage gated channel **K⁺ channels** remain open until membrane is hyperpolarized, eventually they close
- Eventually membrane potential returns to -70 mV with help of Na⁺/K⁺ ATPase

Refractory Period



- Absolute Refractory Period
 - Voltage gated Na⁺ Channel is **inactivated** meaning it cannot open even if there is excitatory input
- Relative Refractory Period
 - Voltage gated Na⁺ Channel is **no longer inactivated**, so it can be opened if the stimulus can overcome the hyperpolarization

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