

# Neuromuscular junction

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# Topics for today

1. Structure and function of the neuromuscular junction
2. Events in the neuromuscular junction transmission
3. Properties and actions of Acetylcholine (Ach) and Acetylcholinesterase (AChE)
4. Toxins affecting the neuromuscular junction
5. Disorders of the neuromuscular junction

## CENTRAL NERVOUS SYSTEM (CNS)

The entire neuron, which is contained within  
the spinal cord/CNS

## PERIPHERAL NERVOUS SYSTEM (PNS)

All or part of the neuron which is contained  
outside the spinal cord/CNS

**AFFERENT SENSORY**

**EFFERENT/MOTOR**

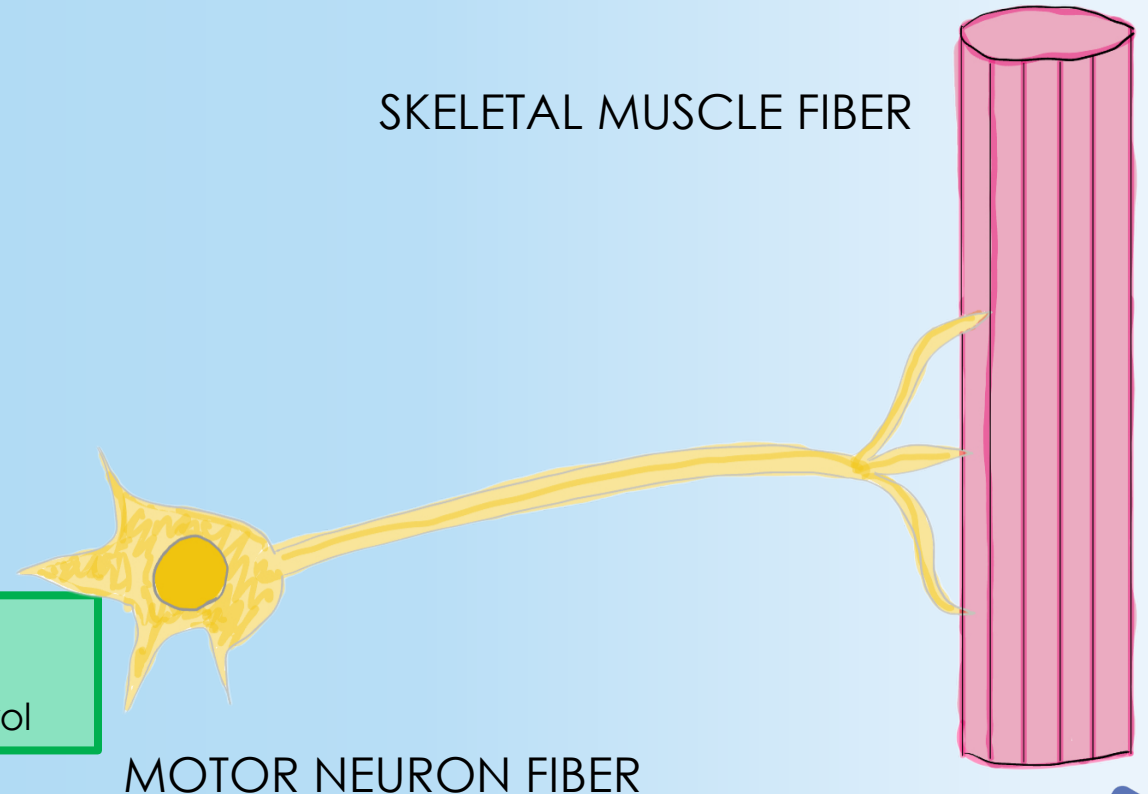
**AUTONOMIC**

Involuntary control

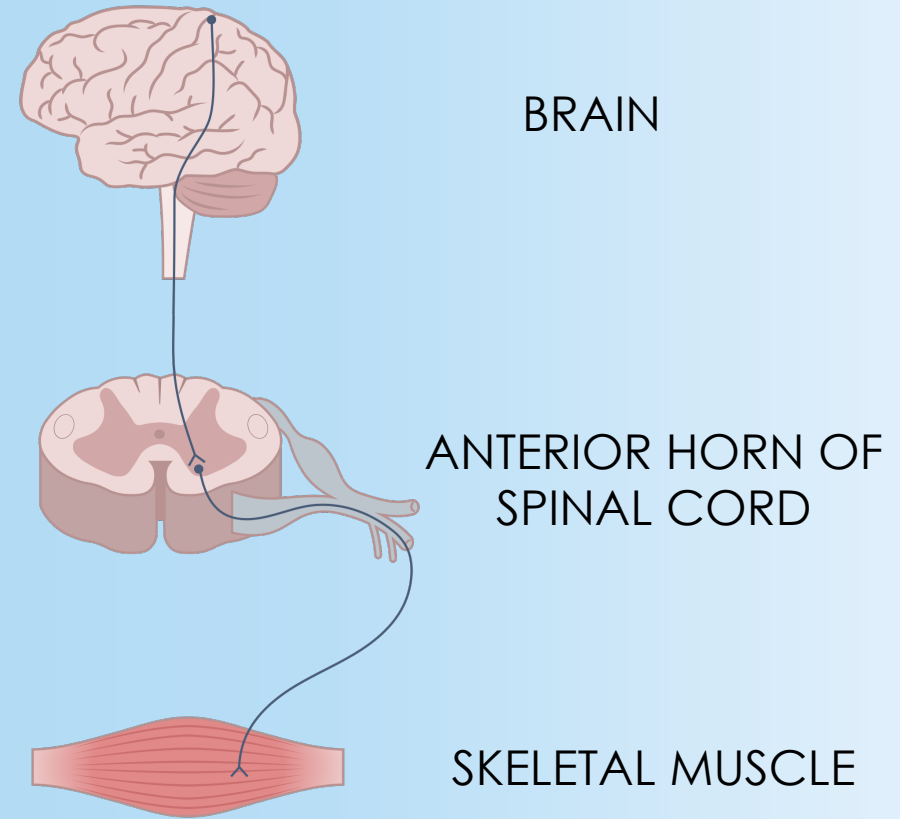
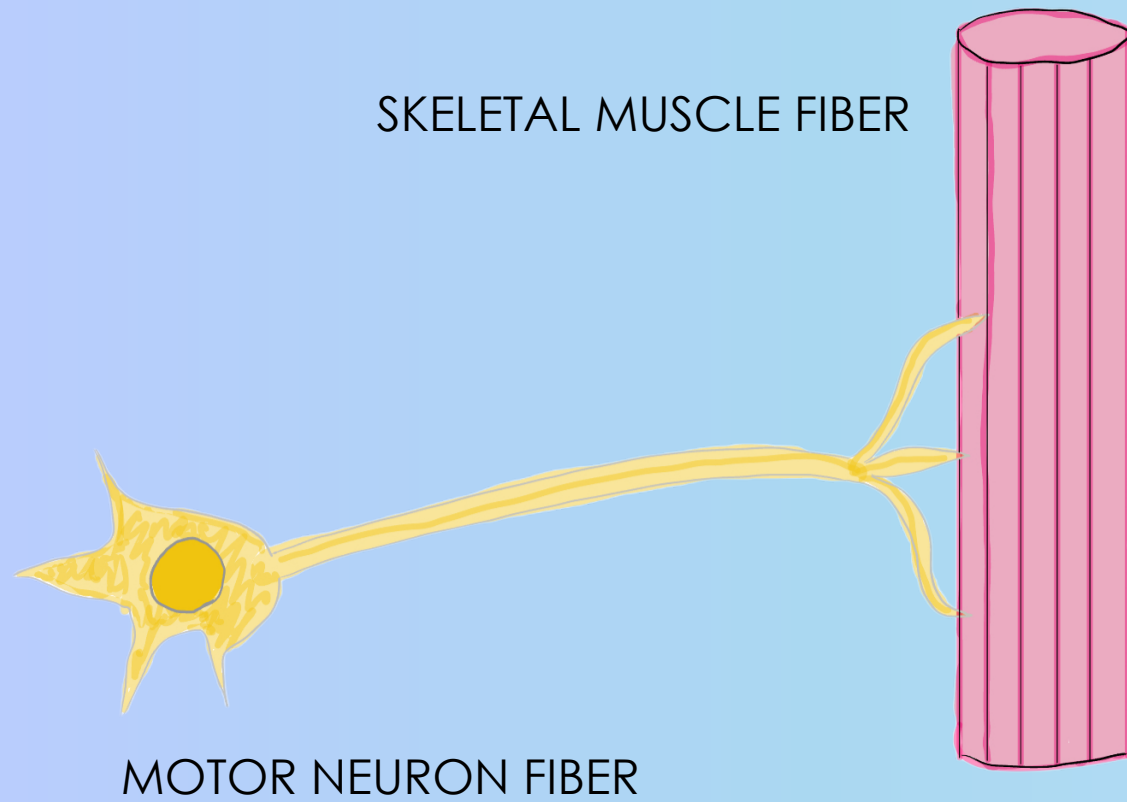
**SOMATIC**

Voluntary control

SKELETAL MUSCLE FIBER

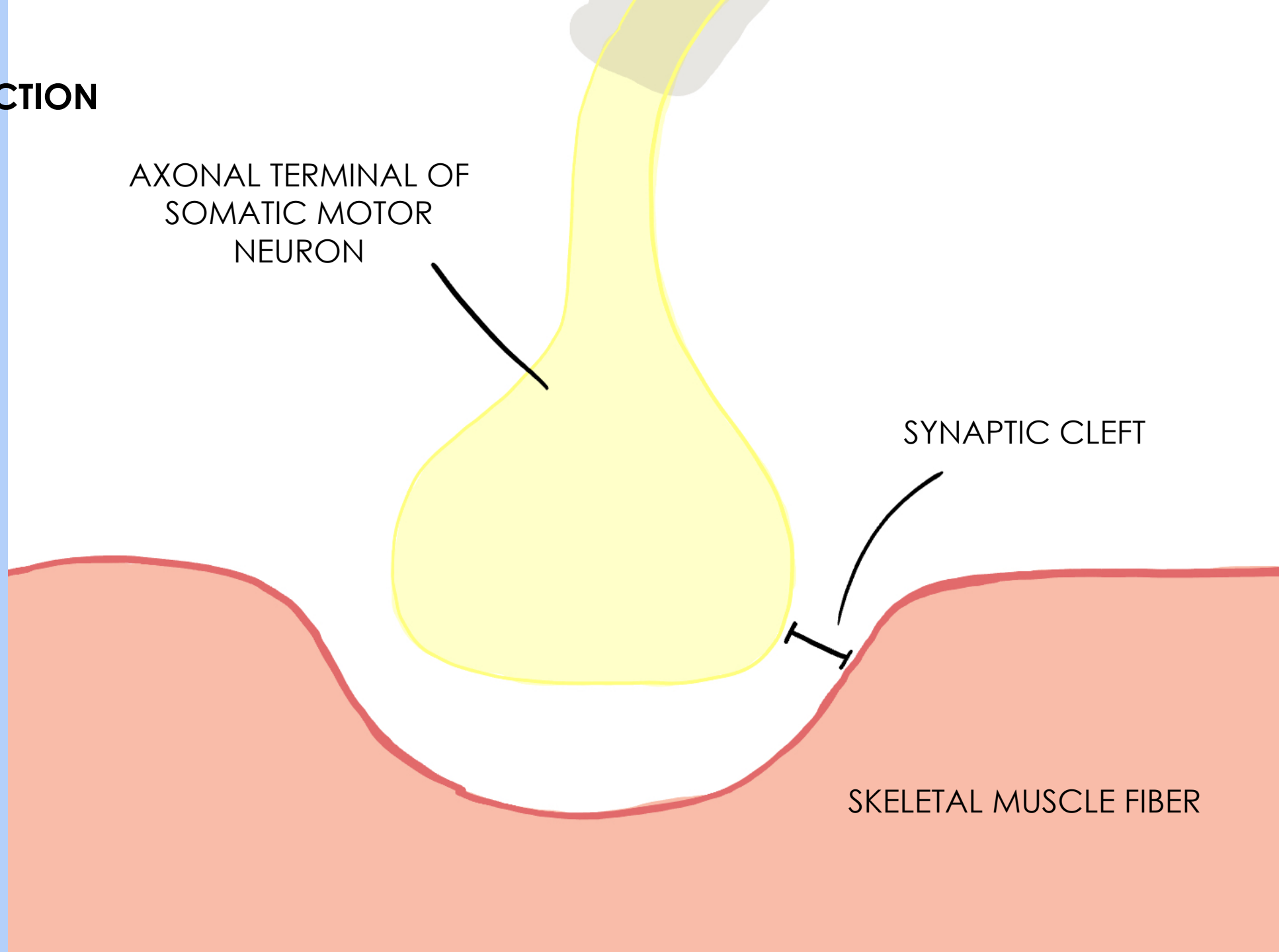


MOTOR NEURON FIBER

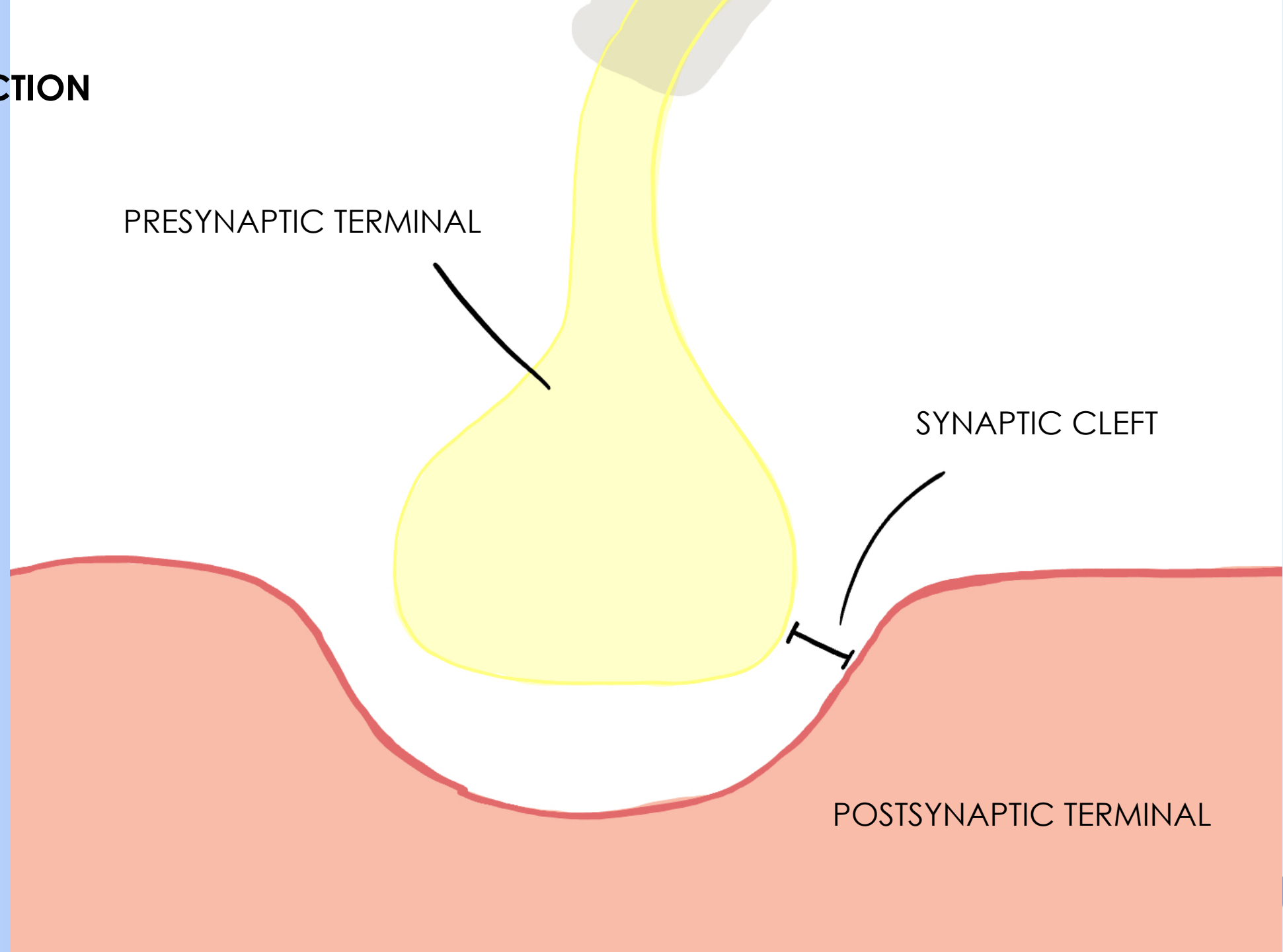


SOMATIC MOTOR NEURON FIBER + SKELETAL MUSCLE FIBER =  
**MOTOR UNIT**

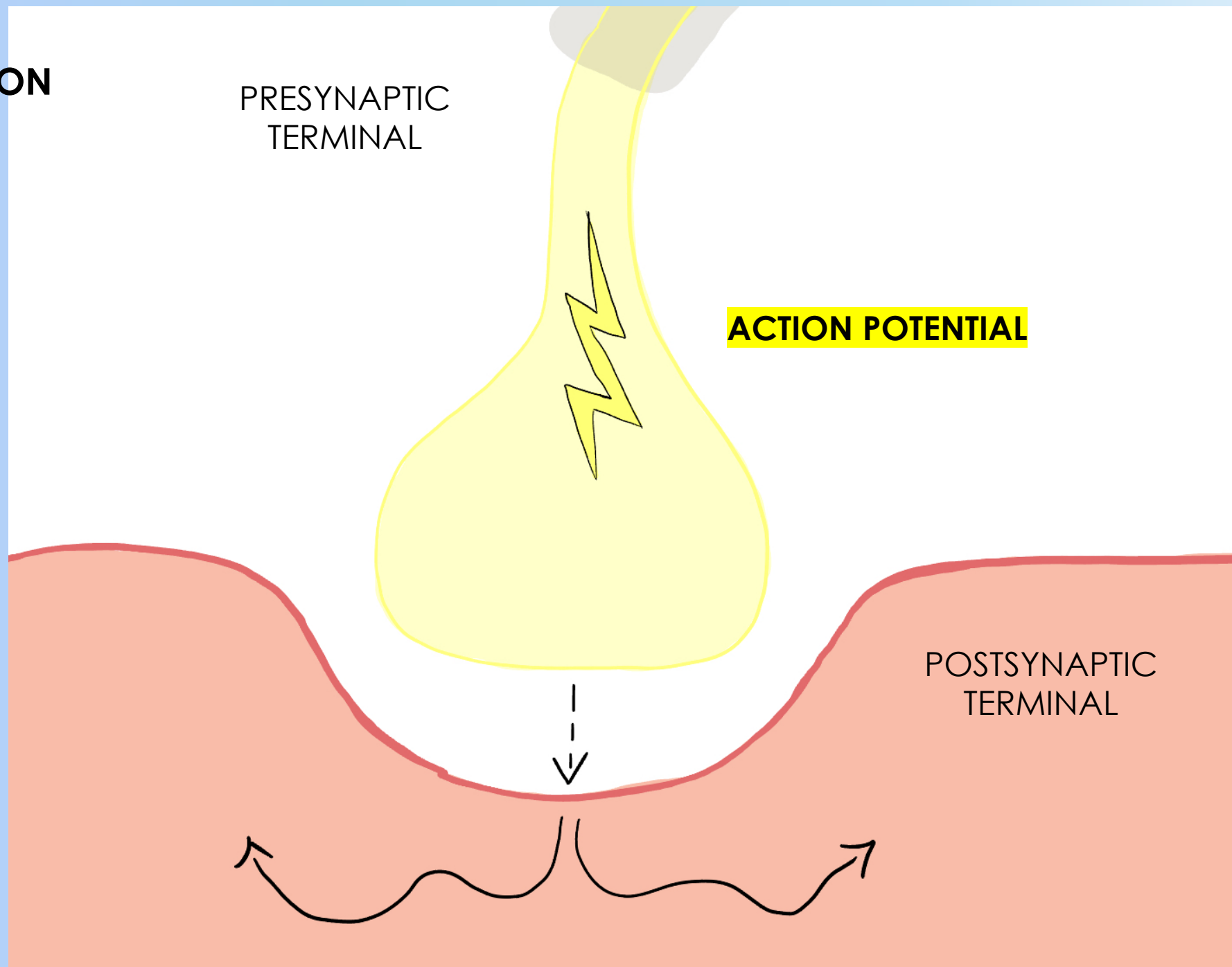
# MUSCLE CONTRACTION



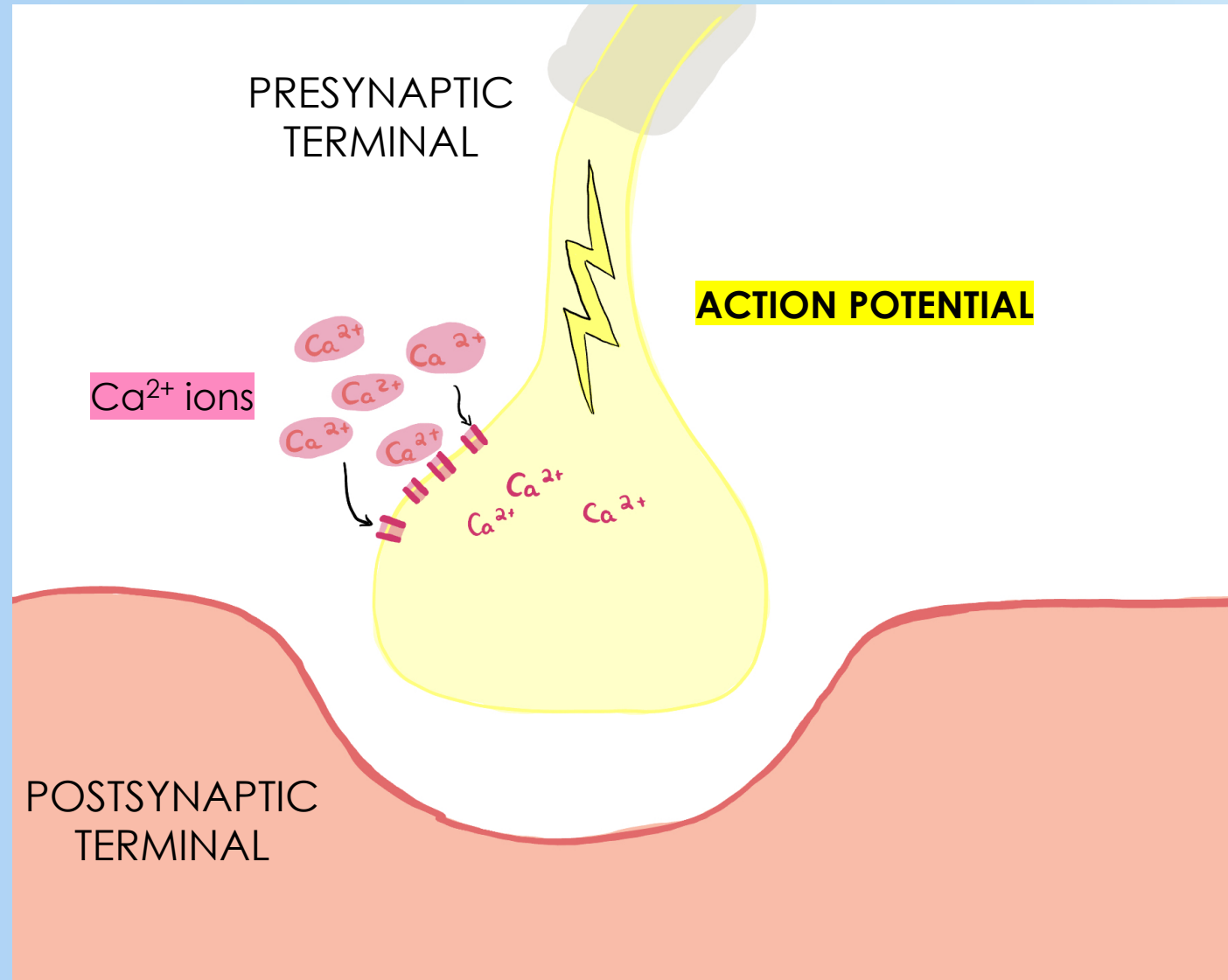
# MUSCLE CONTRACTION



# MUSCLE CONTRACTION

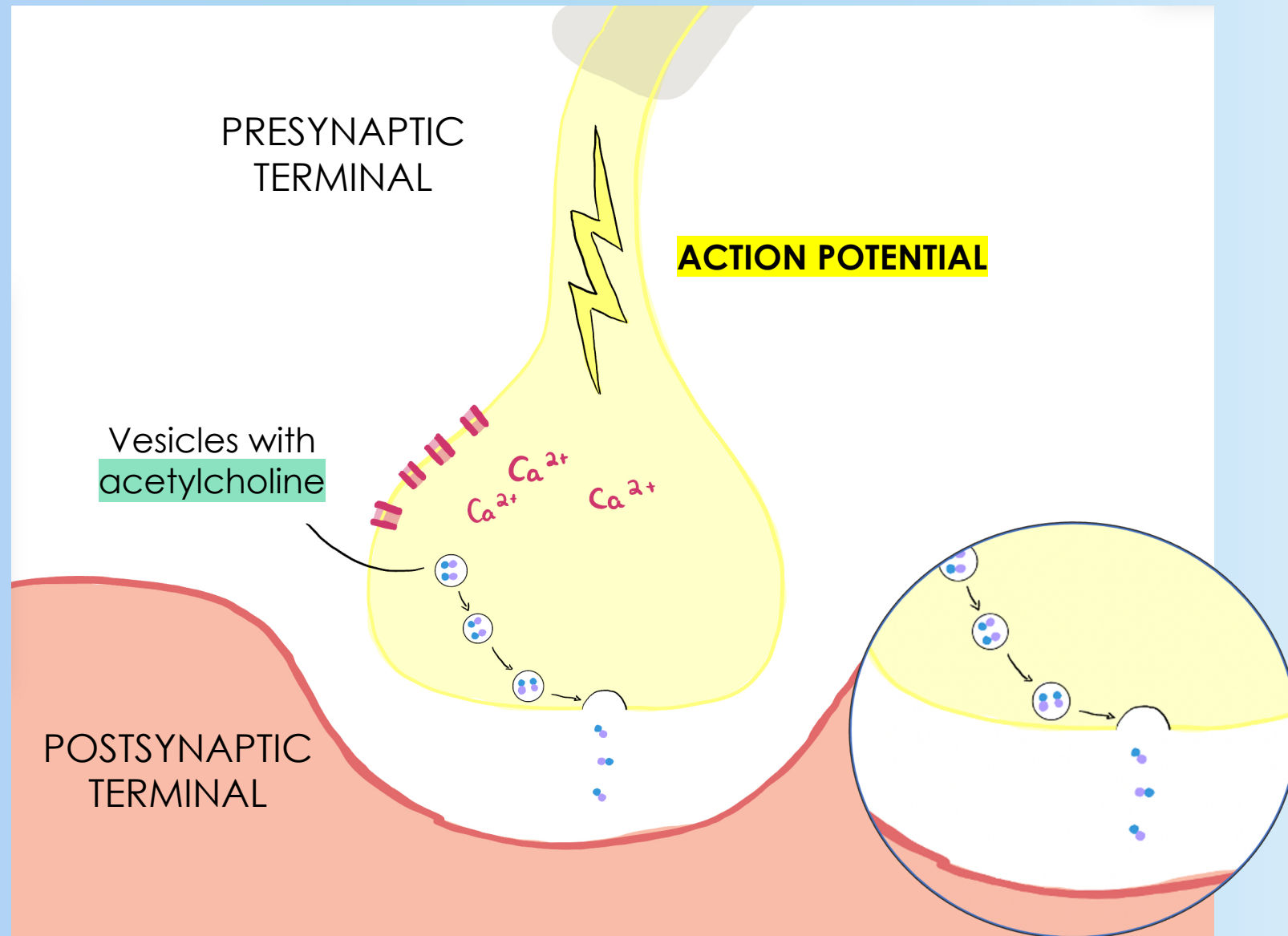


# MUSCLE CONTRACTION



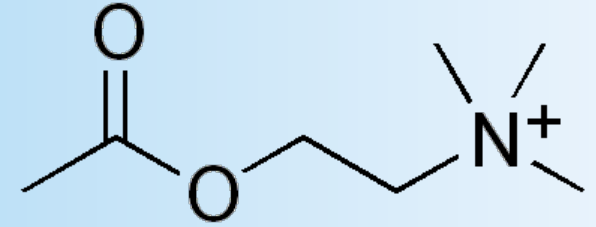
1)  $\text{Ca}^{2+}$  enter the cell via voltage-gated channels located on the presynaptic terminal.

# MUSCLE CONTRACTION



2)  $\text{Ca}^{2+}$  allows vesicles to release acetylcholine into synaptic cleft

# Acetylcholine (ACh)?



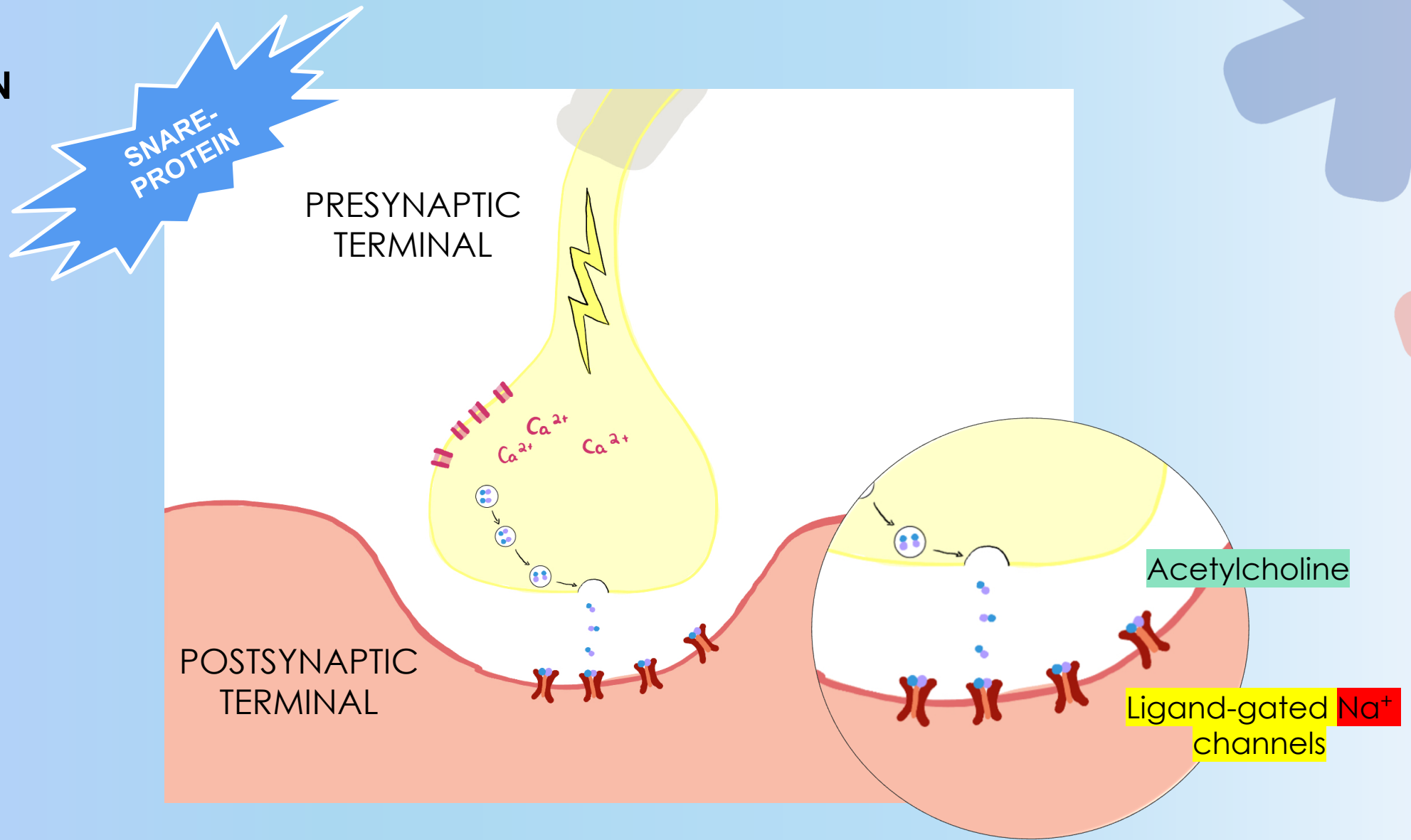
- Excitatory neurotransmitter
- Involved in muscle relaxation AND muscle contraction.

**Nicotinic acetylcholine receptors (nAChRs)** → Skeletal muscle contraction.

**Muscarinic acetylcholine receptors (mAChRs)** → Autonomic nervous system (not NMJ).

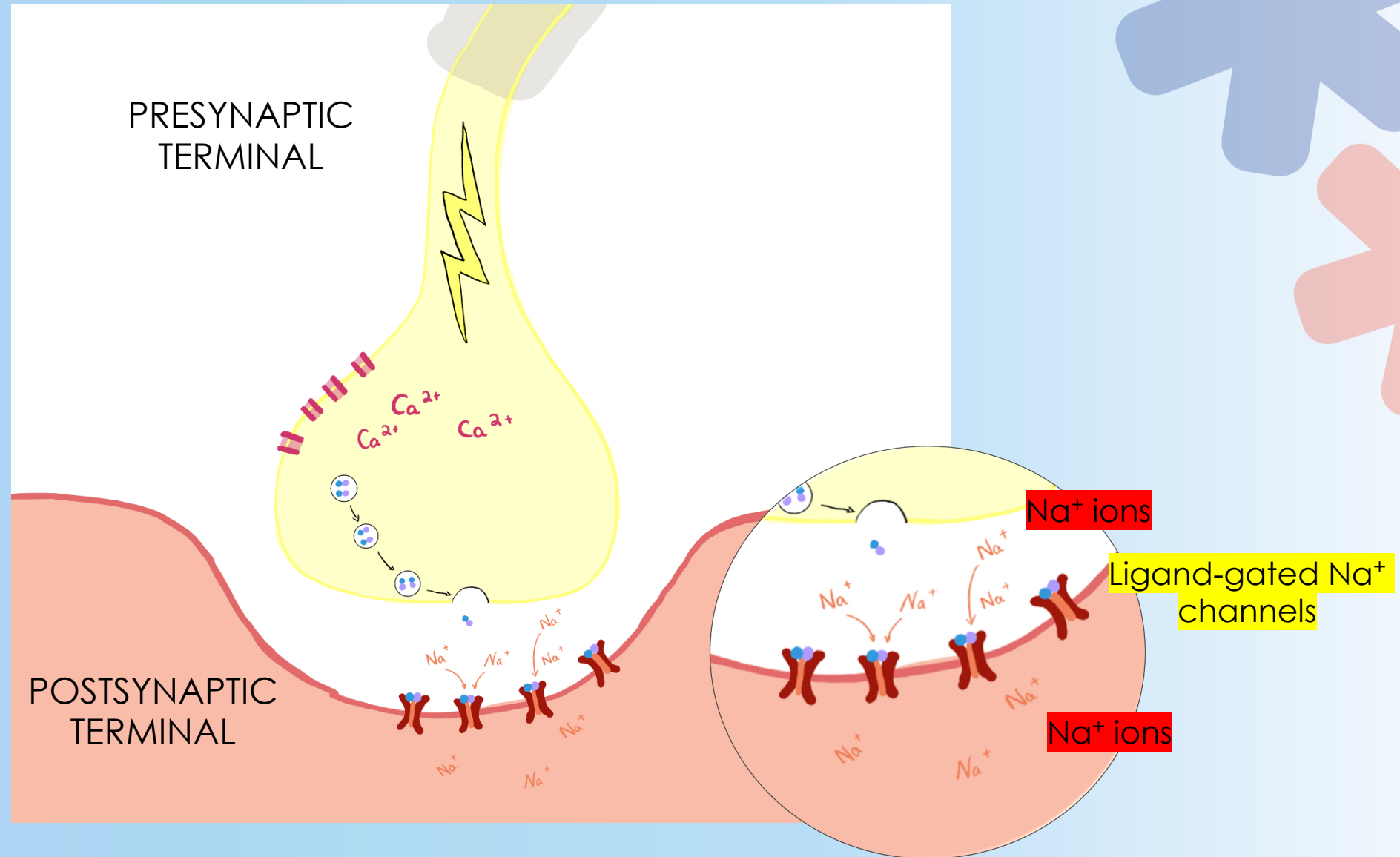
**Produced in:** motor neurons  
**Degraded by:** Acetylcholinesterase (AChE)

# MUSCLE CONTRACTION

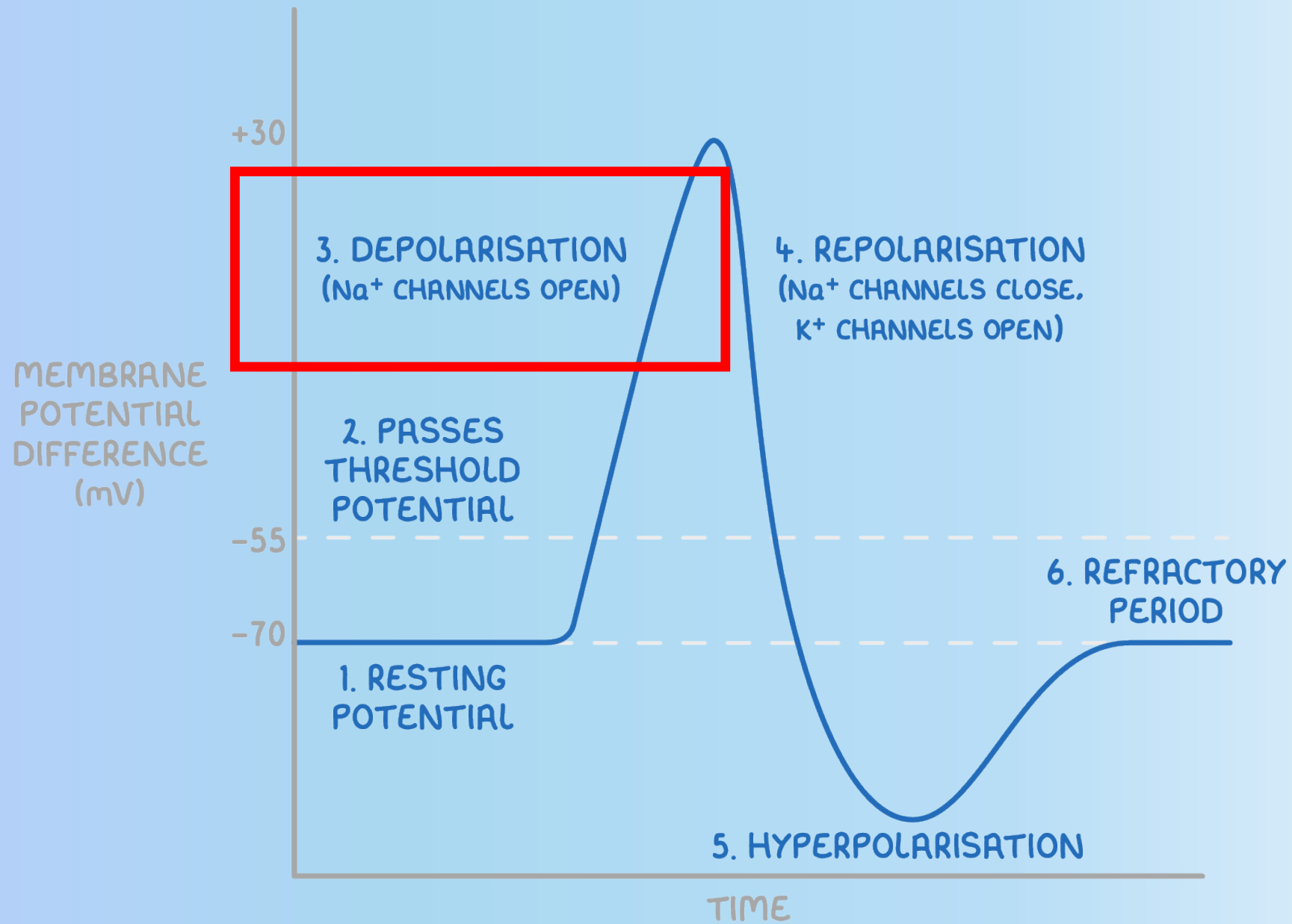


3) **Acetylcholine** binds to ligand gated  $Na^+$  channels on the post-synaptic membrane (skeletal muscle)

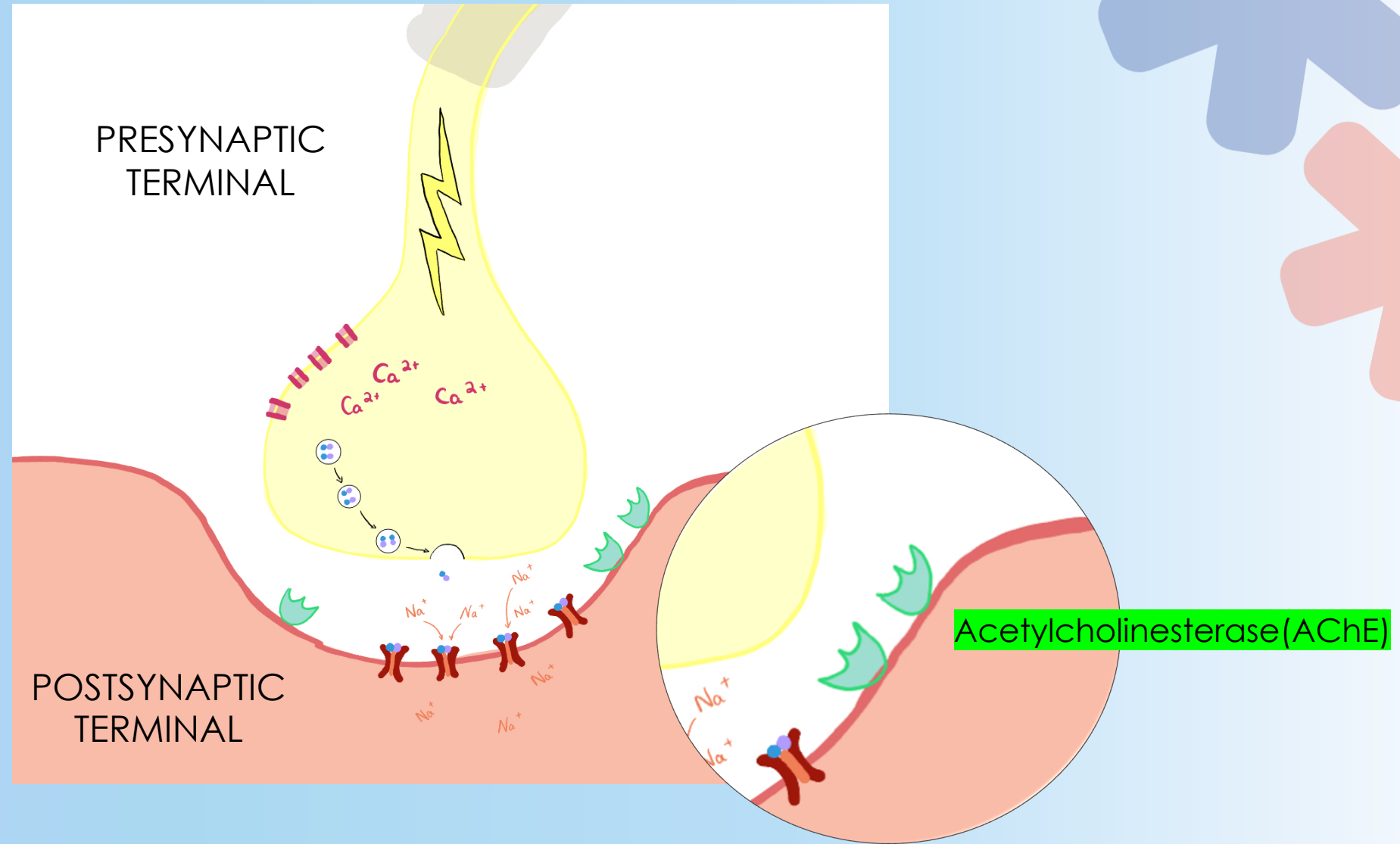
# MUSCLE CONTRACTION



4) The  $\text{Na}^+$  channels open, allowing  $\text{Na}^+$ -ions into the muscle cell --> generates action potential.

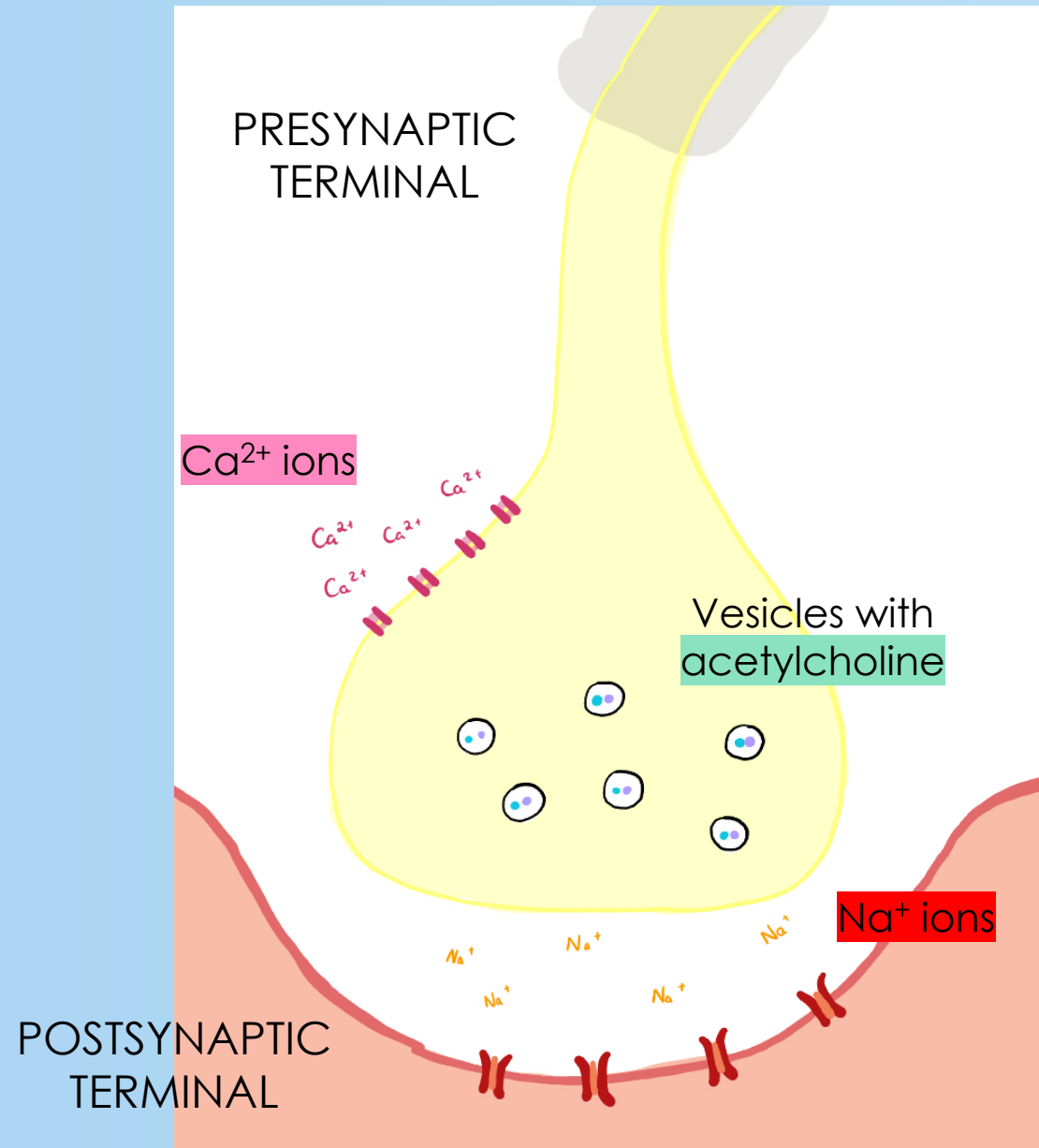


## MUSCLE RELAXATION



5) Activation of muscle cell is complete, and **acetylcholinesterase** breaks down the acetylcholine attached to the post-synaptic terminal

## MUSCLE RELAXATION



6) The synaptic transmission resets and waits for a new action potential

# Acetylcholinesterase (AChE)?

- Enzyme
  - Breaks down Acetylcholine
  - Allow muscle relaxation to happen
  - Resets synaptic transmission
- Acetylcholine → choline + acetate

Too much AChE? Muscle weakness

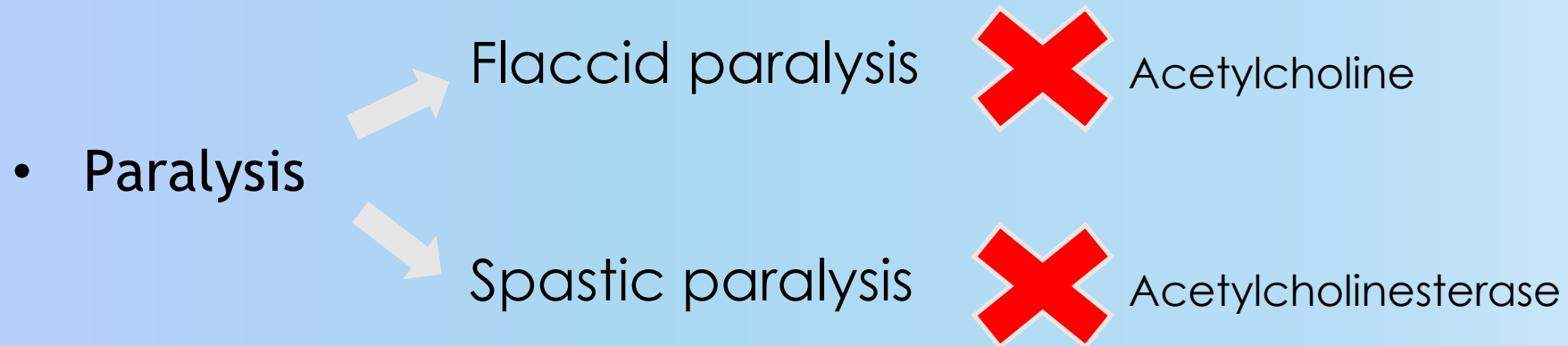
Too little AChE? Muscle overactivation → spastic paralysis

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# Toxins affecting the neuromuscular junction

- Class of drugs/toxin
- Communication block



# Example 1: Succinylcholine



**MOTOR NEURON**



SYNAPTIC CLEFT

**MUSCLE FIBER**

# Example 2: Nicotine



\*(in high doses)

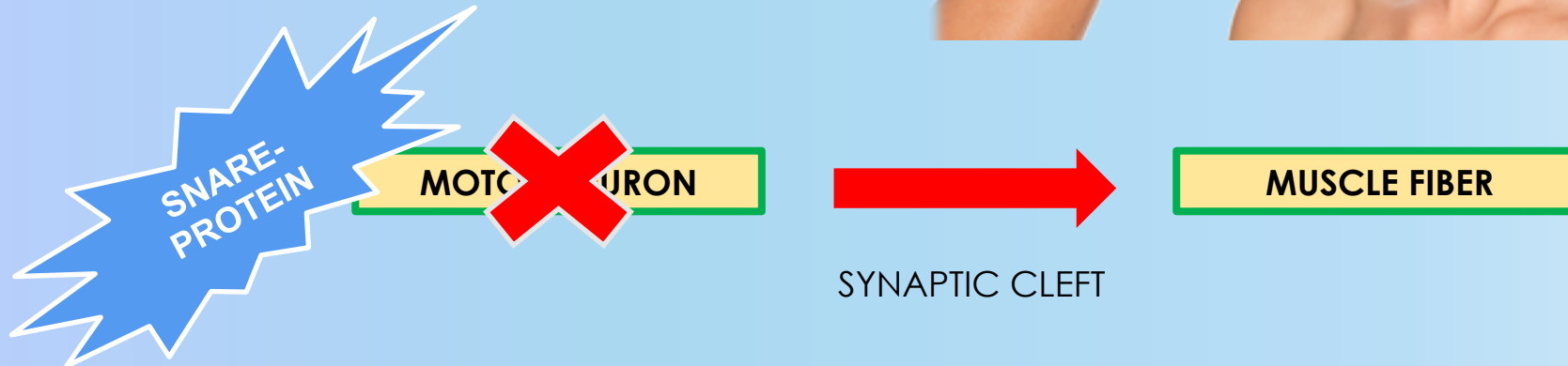
MOTOR NEURON



SYNAPTIC CLEFT

MUSCLE FIBER

# Example 3: Botox - botulinium toxin



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# Myasthenia Gravis



[https://www.youtube.com/watch?v=PKwYJmL\\_ULU](https://www.youtube.com/watch?v=PKwYJmL_ULU)

# Myasthenia Gravis

\*A type II hypersensitivity reaction\*

- Autoimmune disorder
- Autoantibodies attack smooth muscle Ach-receptors
- Unilateral - uneven distribution
- Block receptors - no muscle contraction
- Eye muscles

...but can also attack other muscles -> myasthenic crisis



**Boom - you're done**



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bid

