# NEUROMUSCULAR JUNCTION

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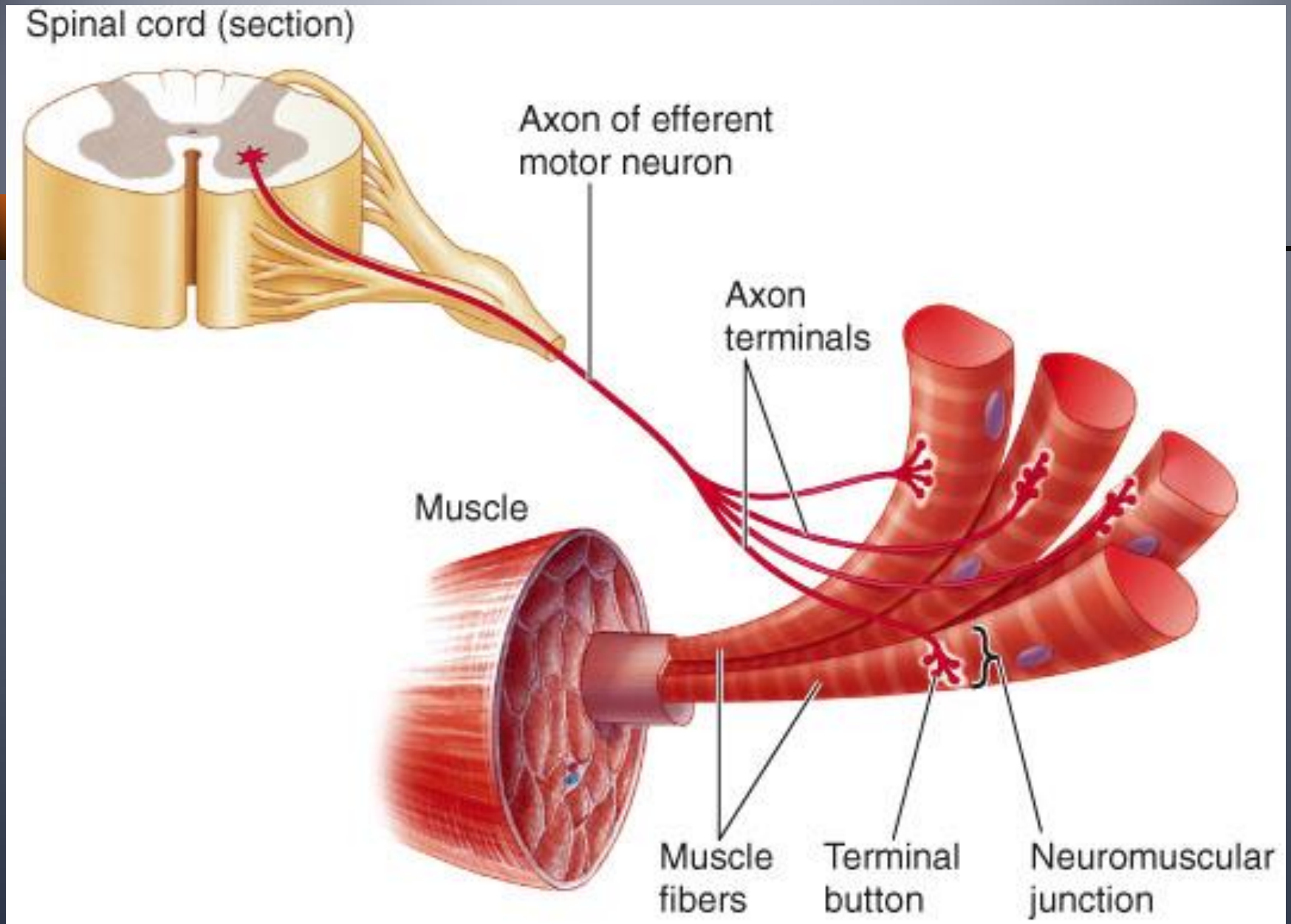
# Neuromuscular junction (example of chemical synapse)

- **Neuromuscular junction :** the synapse between motor neuron and muscle fiber is called the neuromuscular junction
- **Motor neurons :** are the nerves that innervate muscle fibers
- **Motor unit :** single motor neuron and the muscle fibers it innervate

# Physiologic anatomy of N.M junction

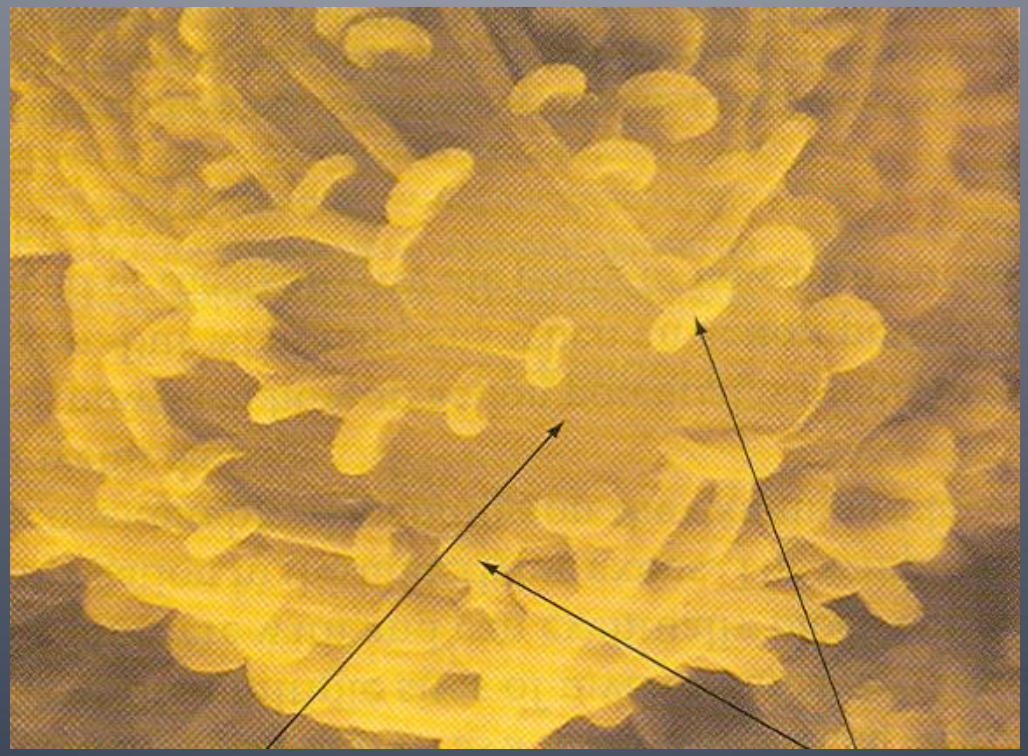
- As axon approaches muscle , it divides into many terminal branches and loses its myelin sheath

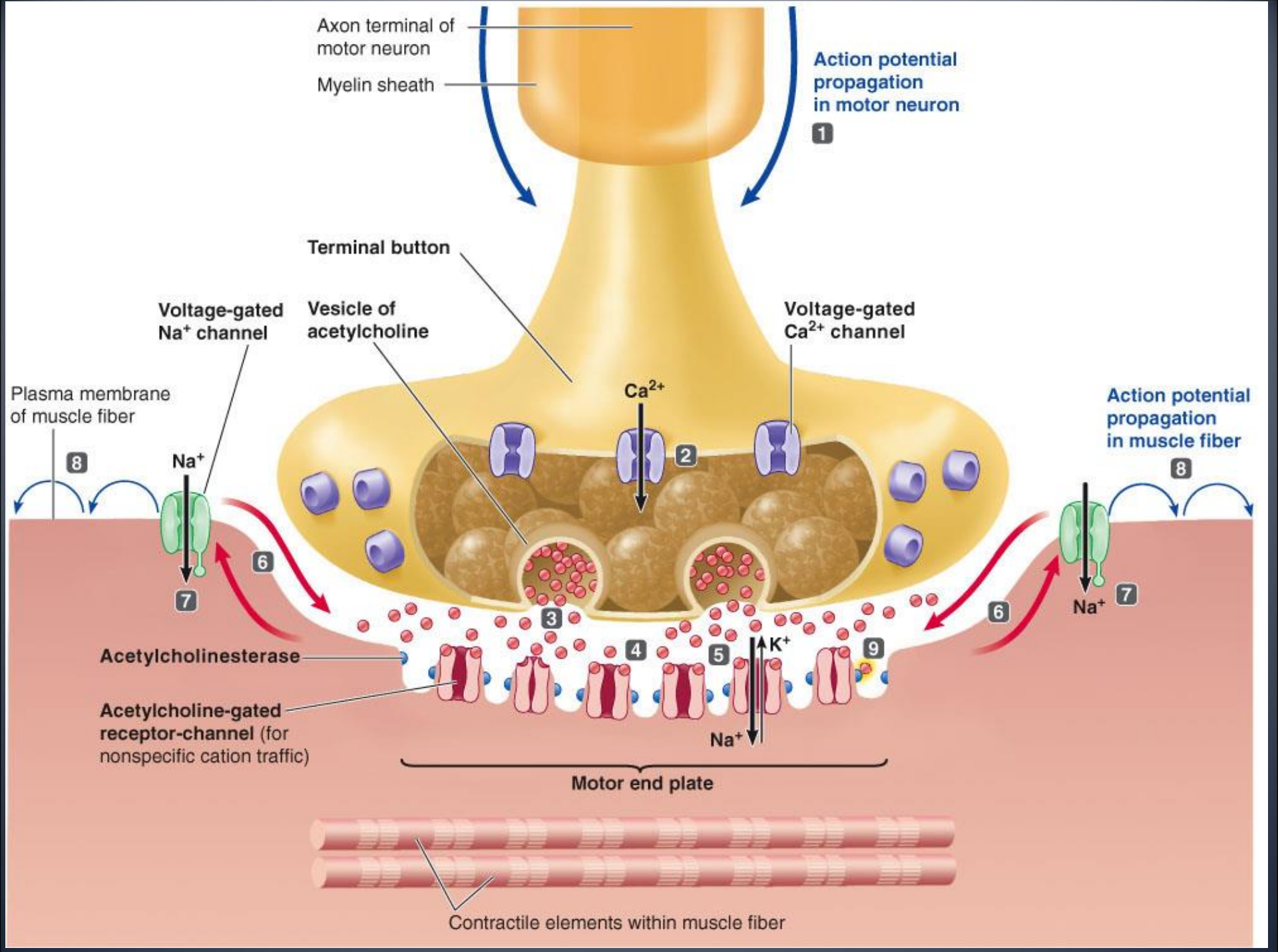
- Each of these axon terminal forms special junction ,a neuromuscular junction with one or more muscle fiber


Spinal cord (section)
Axon of efferent motor neuron
Axon terminals
Muscle
Muscle fibers
Terminal button
Neuromuscular junction

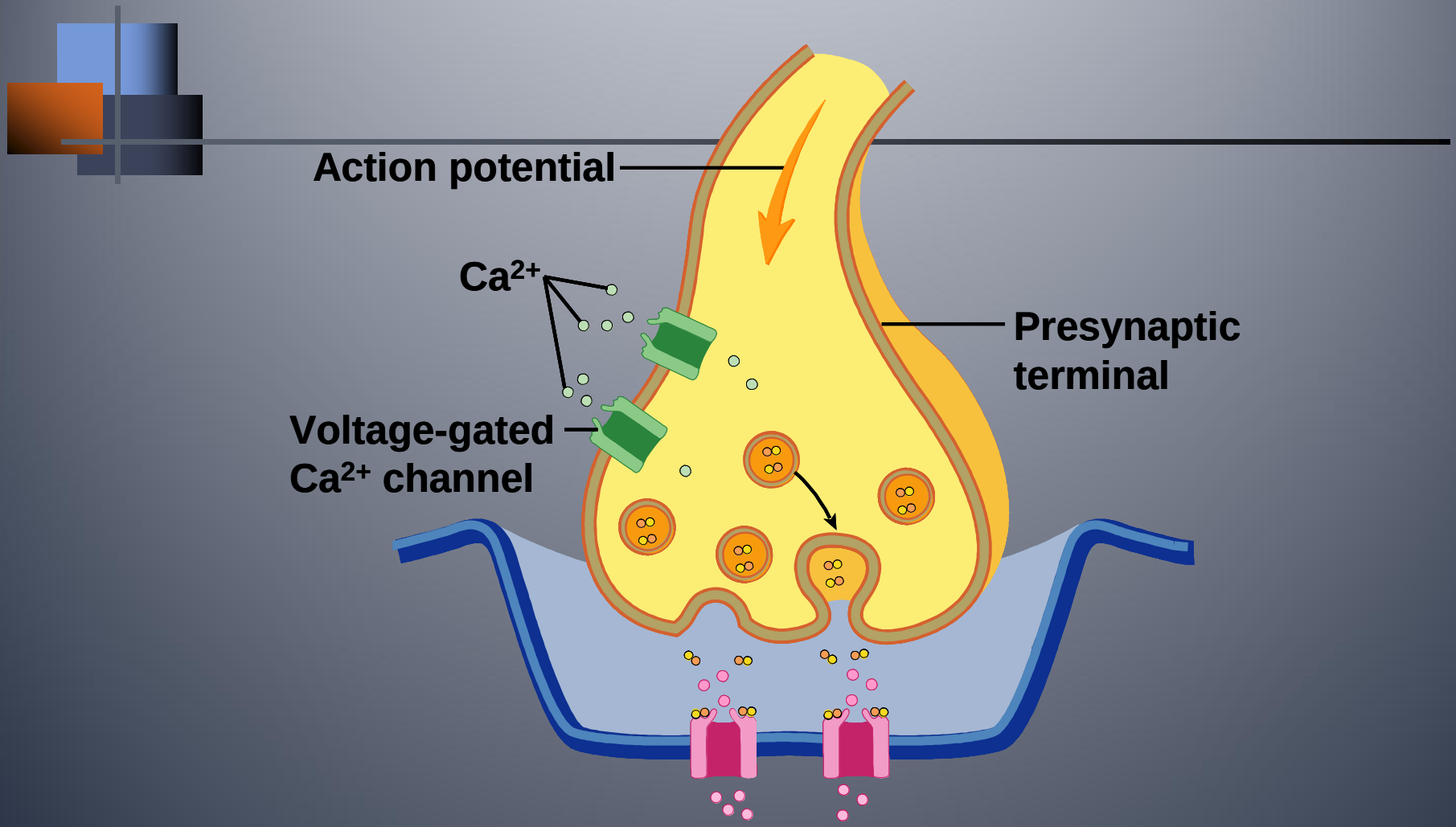
# Physiologic anatomy of N.M junction

- The axon terminal is enlarged into a knoblike structure ,the terminal botton,which fits into shallow depression in underlying muscle fiber



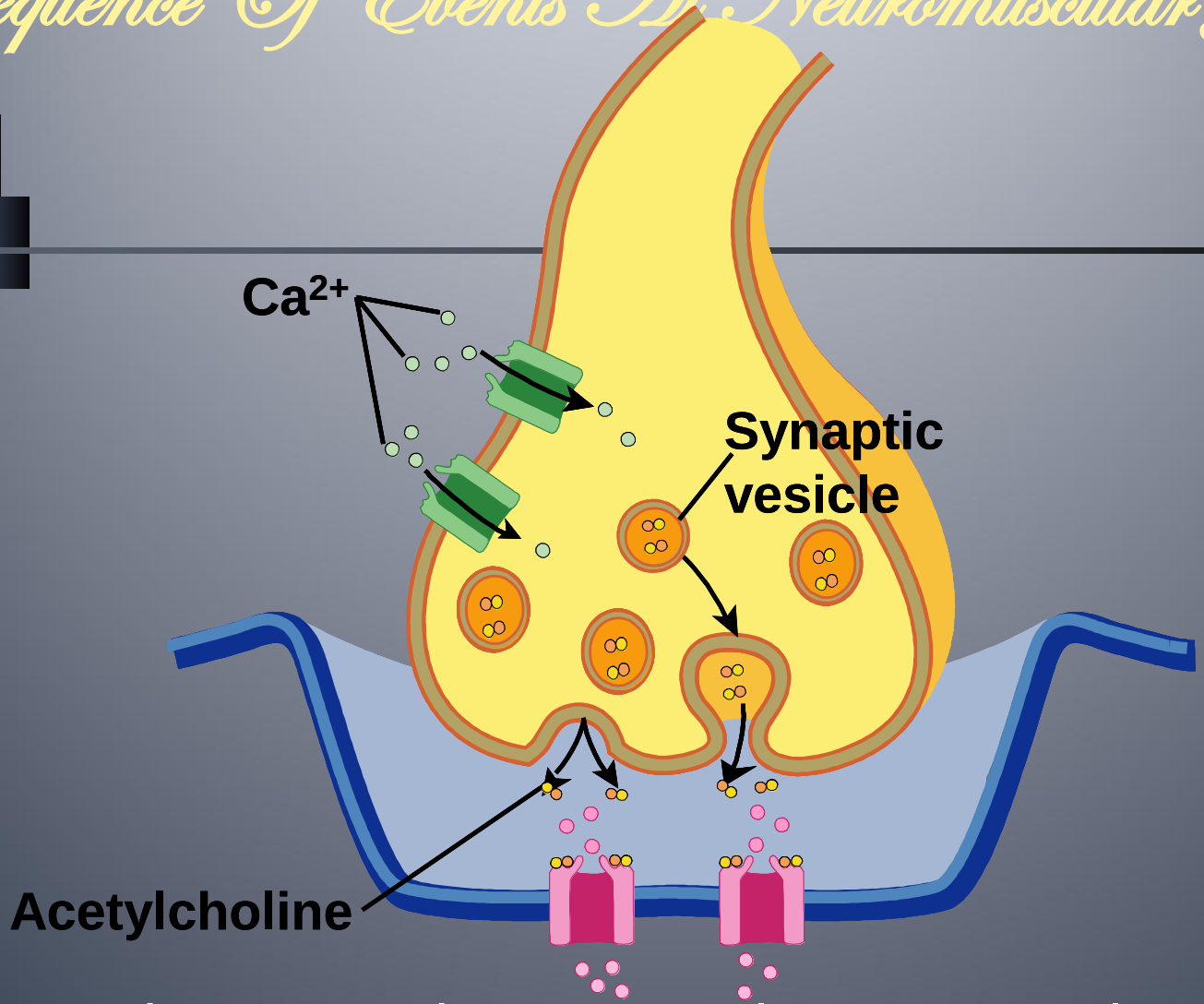

Axon terminal of motor neuron
Myelin sheath
Action potential propagation in motor neuron
1
Terminal button
Voltage-gated Na+ channel
Vesicle of acetylcholine
Voltage-gated Ca2+ channel
Plasma membrane of muscle fiber
Ca2+
2
Action potential propagation in muscle fiber
8
Na+
7
6
3
4
5
K+
9
Acetylcholinesterase
Acetylcholine-gated receptor-channel (for nonspecific cation traffic)
Motor end plate
Contractile elements within muscle fiber

# Sequence Of Events At Neuromuscular Junction



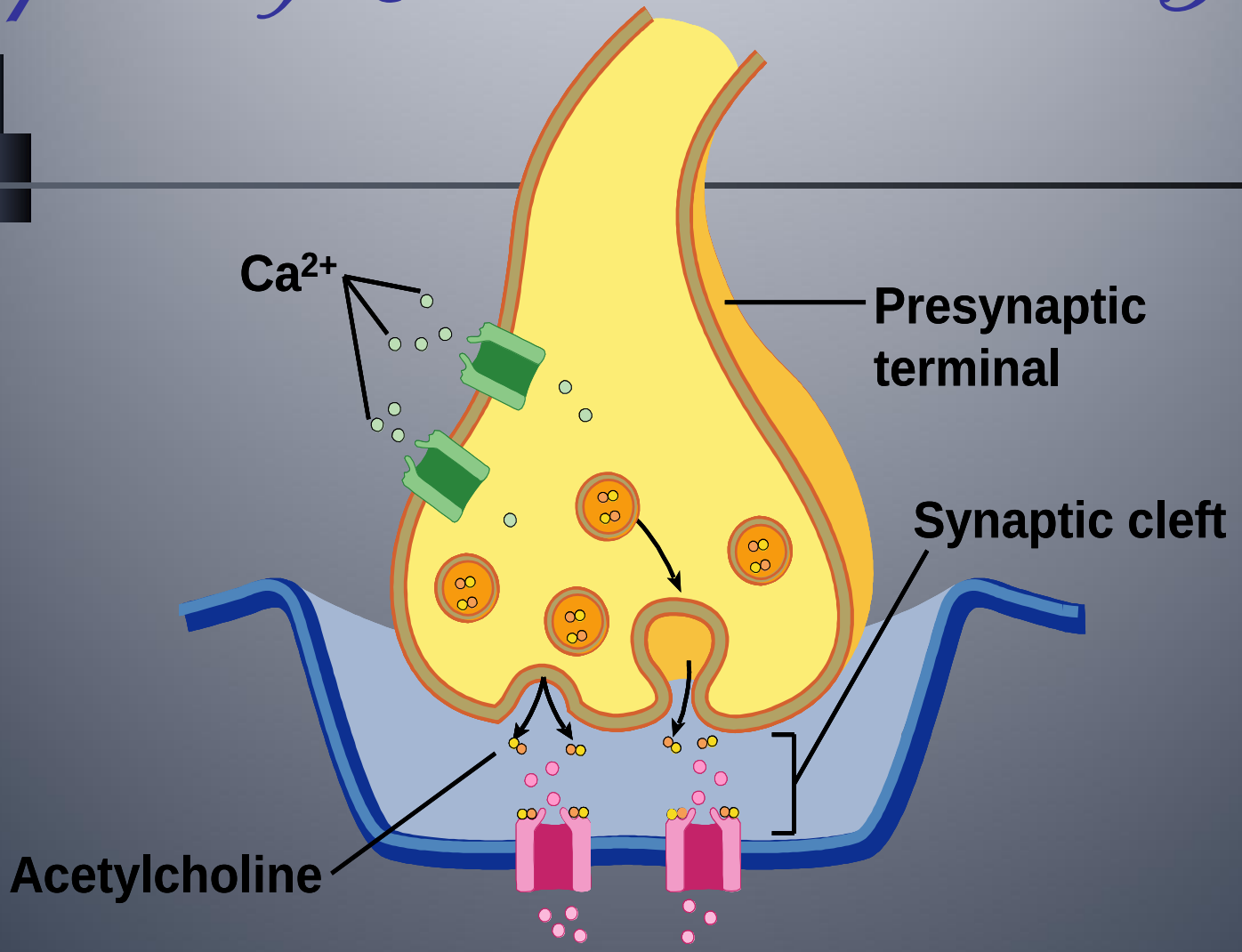

Action potentials arriving at the presynaptic terminal cause voltage-gated $Ca^{2+}$ channels to open.

# Sequence Of Events At Neuromuscular Junction




Ca2+ uptake into the terminal causes release of the neurotransmitter acetylcholine into synaptic cleft , which has been synthesized and stored into synaptic vesicles

# Sequence Of Events At Neuromuscular Junction

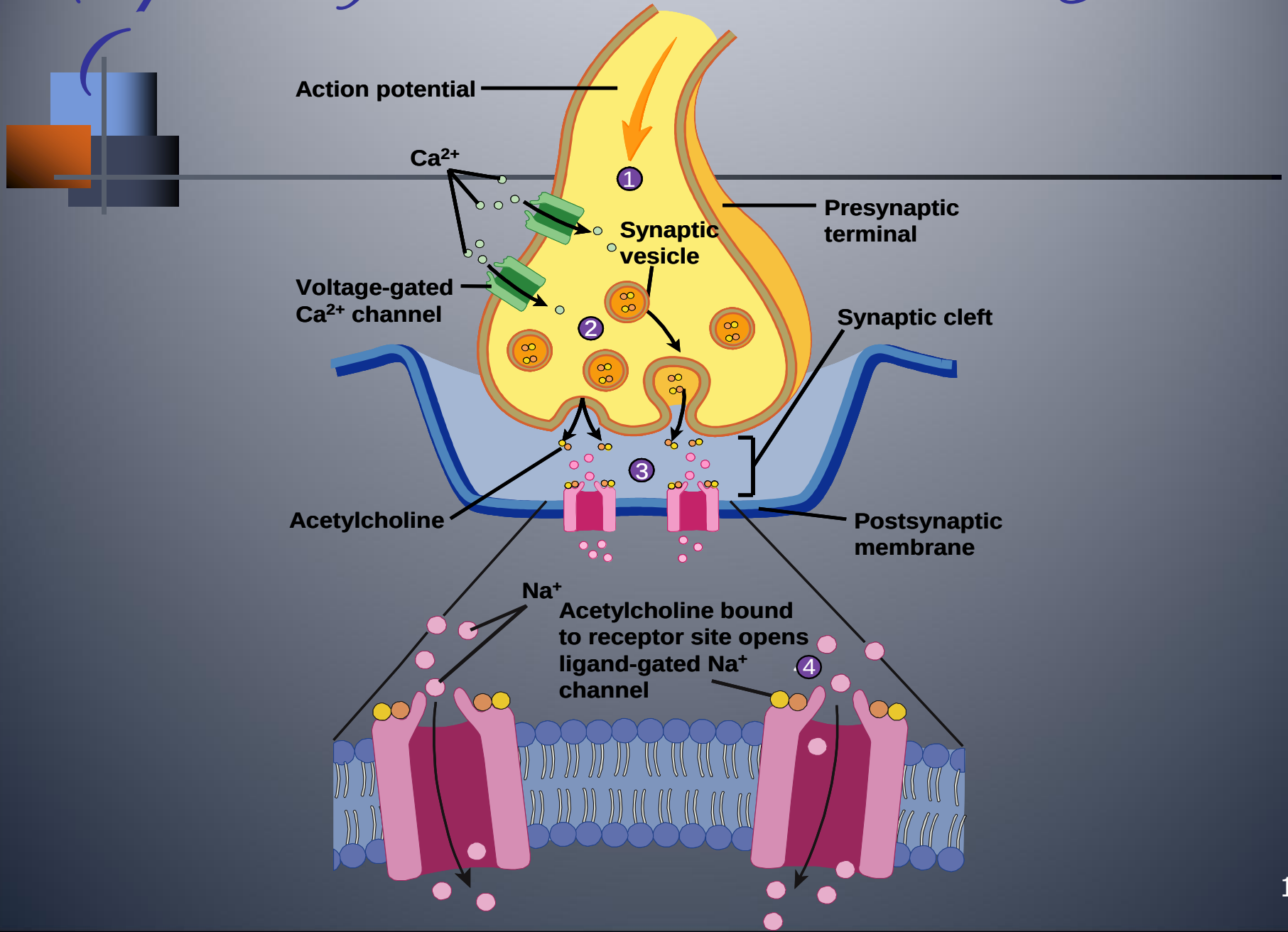



- Ach travels across the synaptic cleft to postsynaptic membrane which is also known as motor end plate.

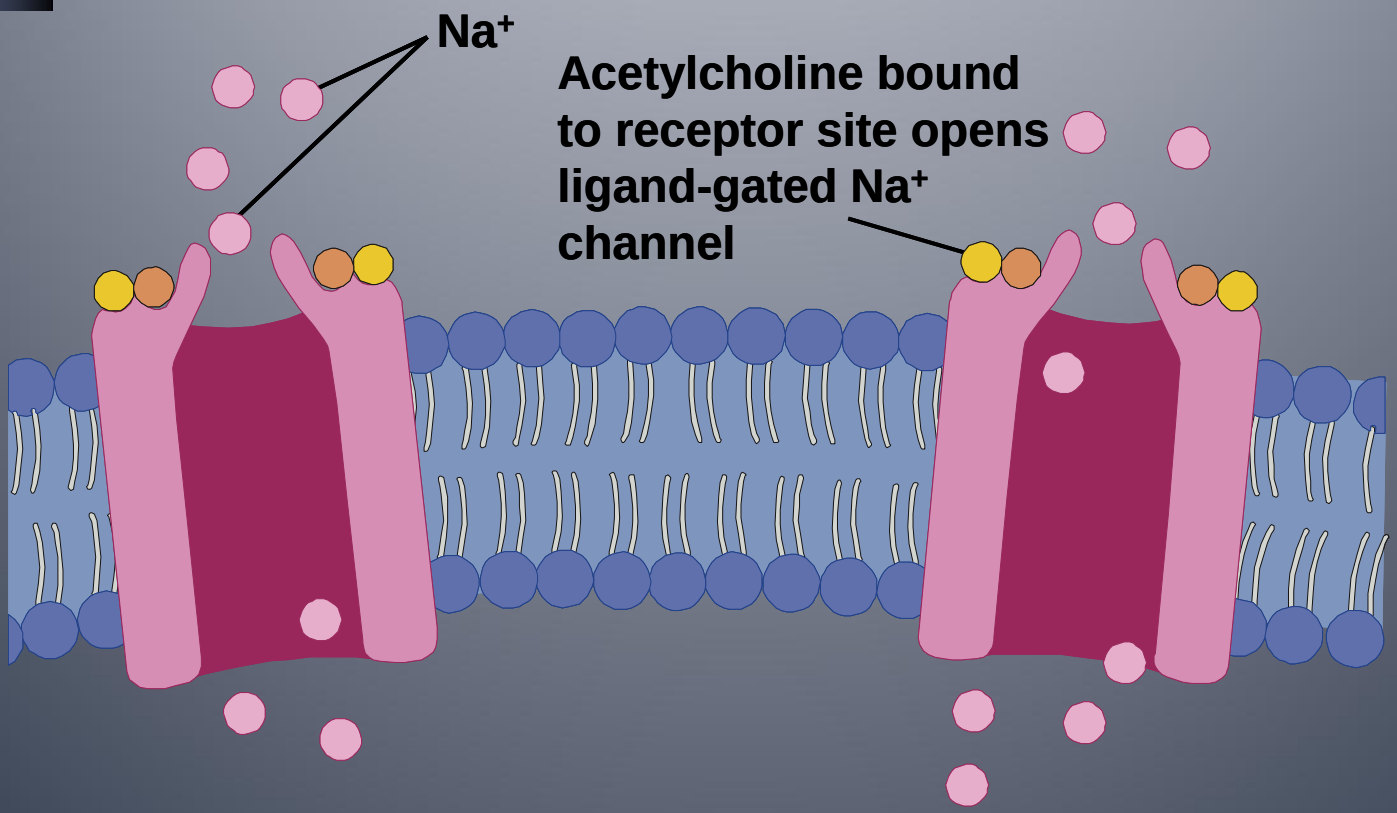
# Sequence Of Events At Neuromuscular Junction

- Motor end plate contains nicotinic receptors for Ach , which are ligand gated ion channels
- Ach binds to the alpha subunits of nicotinic receptors and causes conformational change.
- When conformational changes occurs ,the central core of channels opens & permeability of motor end plate to $Na^+$ & $K^+$ increases

# Sequence Of Events At Neuromuscular Junction



# Sequence Of Events At Neuromuscular Junction




**Acetylcholine molecules combine with their receptor sites and cause ligand-gated $Na^+$ channels to open.**

# End plate potential

- When the ion channel on post synaptic membrane opens both $Na^+$ & $K^+$ flow down their concentration gradient.
- At resting potential net driving force for $Na^+$ is much greater than $K^+$ ,when Ach triggers opening of these channels more $Na^+$ moves inwards than $K^+$ out wards, depolarizing the end plate.this potential change is called end plate potential (EPP).
- EPP is not an action potential but it is simply depolarization of specialized motor end plate

# End plate potential

- Small quanta (packets) of Ach are released randomly from nerve cell at rest, each producing smallest possible change in membrane potential of motor end plate, the MINIATURE EPP.
- When nerve impulse reaches the ending, the number of quanta released increases by several fold and result in large EPP.
- EPP that spread by local current to adjacent muscle fibers which are depolarized to threshold & fire action potential

# Acetyl cholinesterase ends Ach activity at N.M junction

- To ensure purposeful movement ,muscle cell electrical response is turned off by acetylcholinestrase(AchE), which degrade Ach to choline & acetate
- About 50%of choline is returned to the presynaptic terminal by $Na^{+}$choline transport to be reused for Ach synthesis.
- Now muscle fiber can relax ,if sustained contraction is needed for the desired movement another motor neuron AP leads to release of more Ach

# Things to Remeber

- Axon terminal of motor neuron forms neuromuscular junction muscle cell
- Signals are passed between nerve terminal and muscle fiber by means of neurotransmitter ACh
- Released ACh binds to receptor sites on motor end plate of muscle cell membrane
- Binding triggers opening of specific channels in motor end plate
- Ion movements depolarize motor end plate, producing end-plate potential
- Local current flow between depolarized end plate and adjacent muscle cell membrane brings adjacent areas to threshold
- Action potential is initiated and propagated throughout muscle fiber