SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT : PHYSICIAN ASSISTANT

COURSE NAME : NEUROLOGY

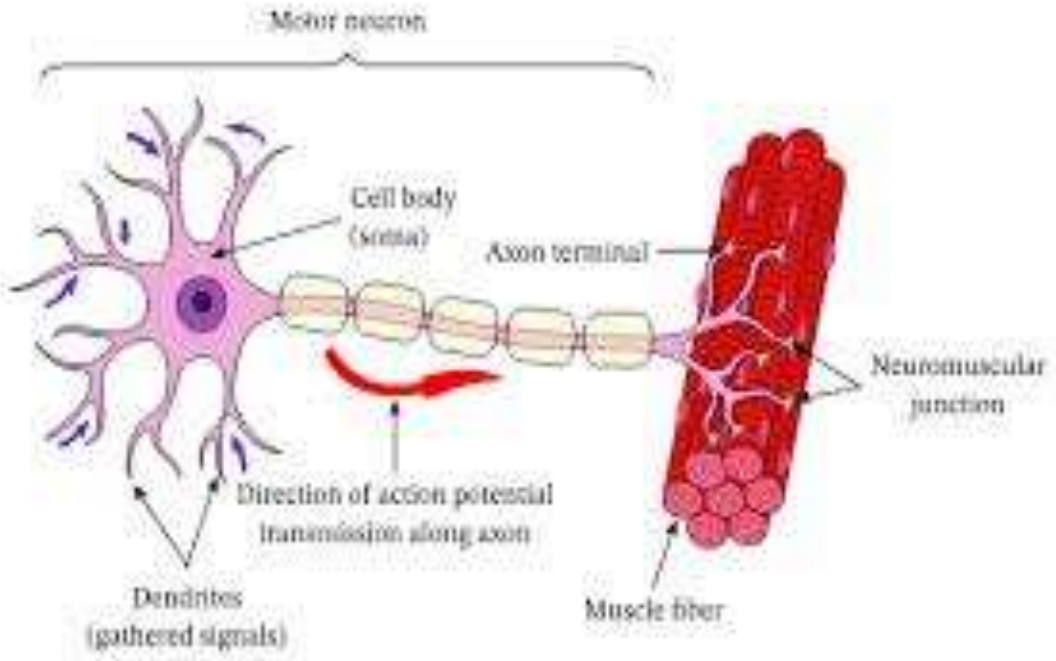
UNIT : NERVOUS SYSTEM

TOPIC : NEUROMUSCULAR JUNCTION

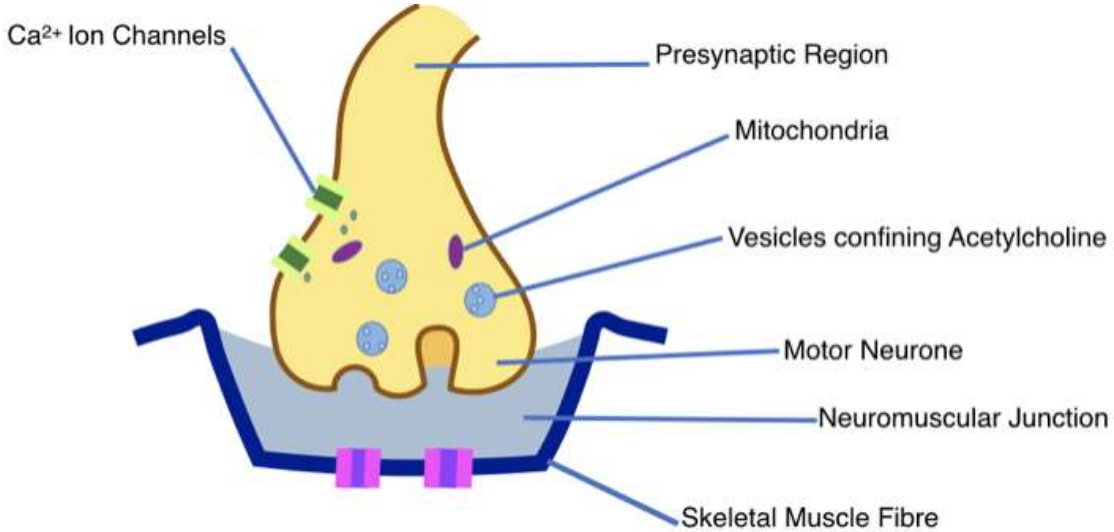
NEUROMUSCULAR JUNCTION

- The neuromuscular junction (NMJ) is a specialized synapse or junction between a motor neuron and a skeletal muscle fiber.

- It serves as the primary site for communication between the nervous system and the muscular system, facilitating the transmission of nerve impulses from motor neurons to muscle fibers, which ultimately leads to muscle contraction.


Motor neuron
Cell body
(soma)
Axon terminal
Neuromuscular
junction
Direction of action potential
transmission along axon
Dendrites
(gathered signals)
Muscle fiber

- Synapses can be anywhere – e.g. between two neurones, between a neurone and a muscle.
- A neuromuscular junction occurs between a motor neurone and an effector muscle cell.
- Neuromuscular junctions use acetylcholine (a type of neurotransmitter), which binds to nicotinic cholinergic receptors on the muscle cells.


Ca2+ Ion Channels
Presynaptic Region
Mitochondria
Vesicles confining Acetylcholine
Motor Neurone
Neuromuscular Junction
Skeletal Muscle Fibre

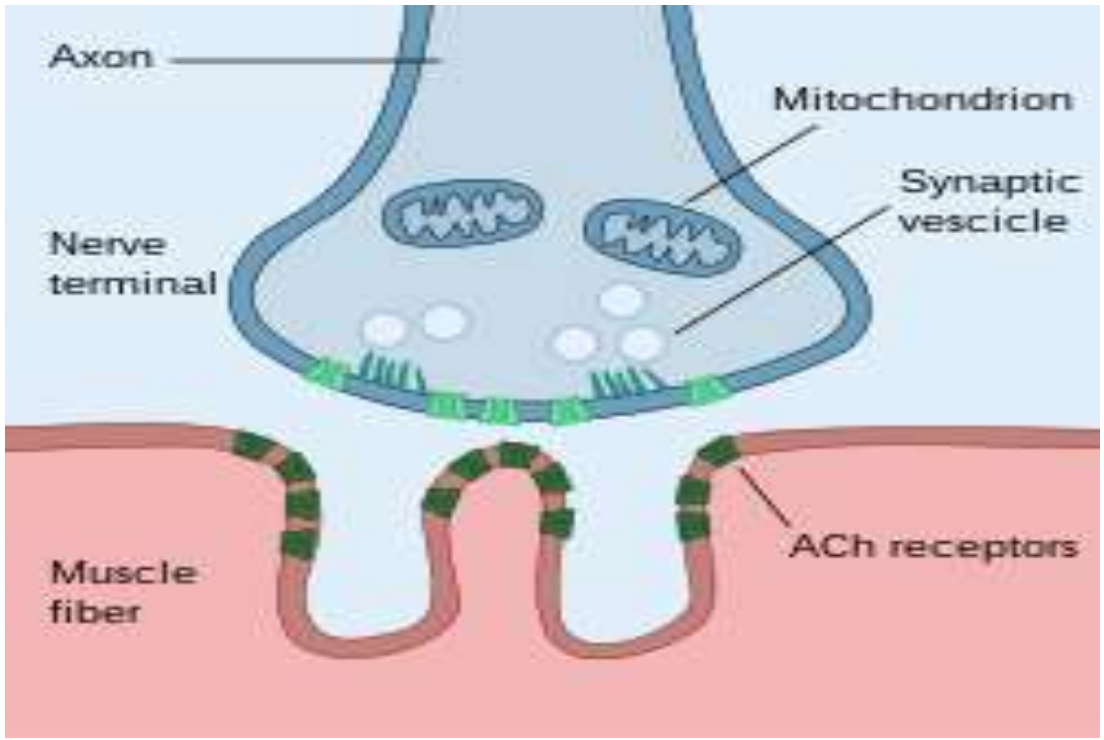
TRANSMISSION ACROSS NEUROMUSCULAR JUNCTION

- Action potential reaches the synaptic knob.
- Voltage-gated calcium channels open and calcium ions rush into the pre-synaptic neurone.
- Synaptic vesicles fuse with the pre-synaptic membrane.

- Acetylcholine is released and diffuses across the synaptic cleft.

- Acetylcholine binds with nicotinic cholinergic receptors on the muscle cell membrane.

- Sodium-ion channels open which causes depolarisation, leading to muscle contraction.


Axon
Mitochondrion
Synaptic vescicle
Nerve terminal
ACh receptors
Muscle fiber

STRUCTURE OF THE NEUROMUSCULAR JUNCTION

- **Motor Neuron Terminal:** At the presynaptic side of the NMJ, the axon terminal of the motor neuron forms enlarged structures known as motor end plates.

- These terminals contain synaptic vesicles filled with acetylcholine (ACh), the neurotransmitter responsible for transmitting signals across the NMJ.

- **Synaptic Cleft:** The synaptic cleft is the narrow gap between the motor neuron terminal and the muscle fiber.

- It separates the presynaptic membrane of the motor neuron from the postsynaptic membrane of the muscle fiber.

- **Motor End Plate:** The motor end plate refers to the specialized region of the muscle fiber membrane (sarcolemma) located directly opposite the motor neuron terminal.

- It contains a high density of acetylcholine receptors (AChRs), which bind ACh released by the motor neuron.

- **Acetylcholine Receptors (AChRs):** AChRs are ligand-gated ion channels located on the postsynaptic membrane of the motor end plate.

- Binding of ACh to AChRs triggers depolarization of the muscle fiber membrane, initiating muscle contraction.

FUNCTIONS OF NEUROMUSCULAR JUNCTION

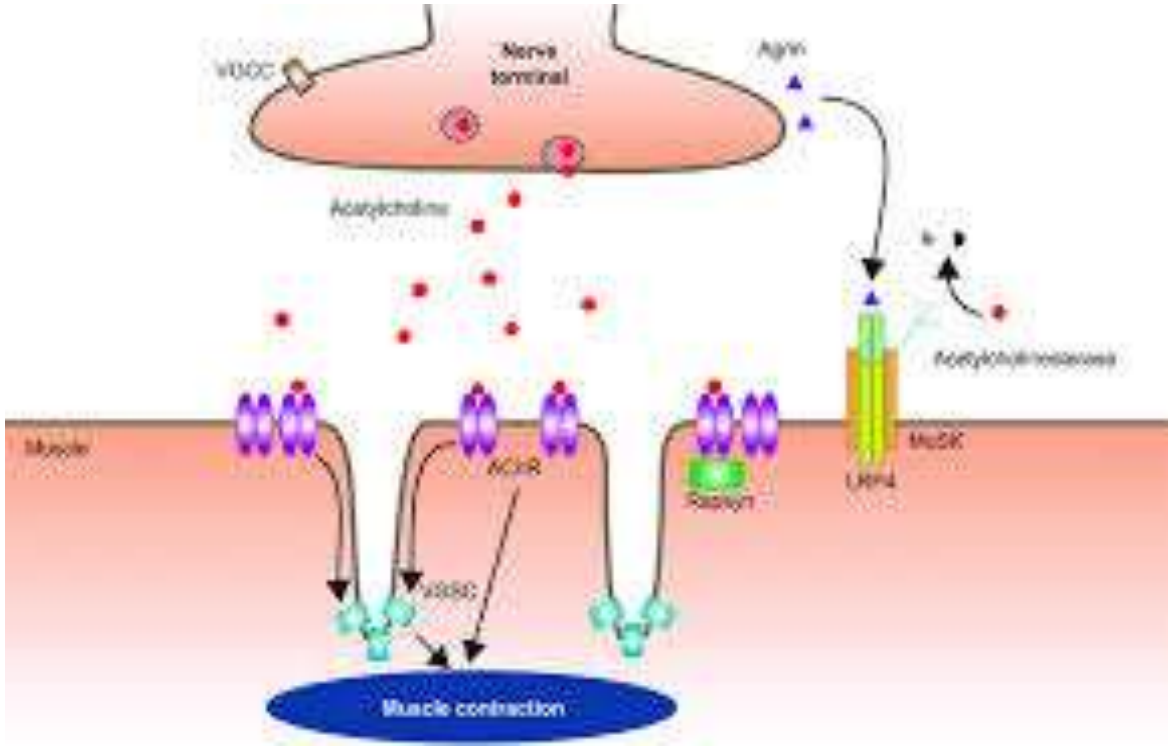
- **Synaptic Transmission:** When an action potential reaches the motor neuron terminal, it depolarizes the membrane, leading to the opening of voltage-gated calcium channels.

- The influx of calcium ions triggers the fusion of synaptic vesicles with the presynaptic membrane, releasing ACh into the synaptic cleft via exocytosis.

- **ACh Binding and Depolarization:** ACh diffuses across the synaptic cleft and binds to AChRs on the motor end plate. This binding causes conformational changes in the AChRs, leading to the opening of ion channels and the influx of sodium ions into the muscle fiber.

- This influx of positive ions results in depolarization of the muscle fiber membrane, generating an end-plate potential (EPP).

- **Muscle Fiber Action Potential:** If the EPP is of sufficient magnitude to reach the threshold for voltage-gated sodium channels, it triggers an action potential that propagates along the muscle fiber membrane and initiates muscle contraction.


VGCC
Nerve terminal
Agrin
Acetylcholine
Acetylcholinesterase
Muscle
AChR
MuSK
Rapsyn
LRP4
VGSC
Muscle contraction

- **Muscle Contraction:** The action potential propagates along the muscle fiber membrane and into the T-tubules, leading to the release of calcium ions from the sarcoplasmic reticulum.

- Calcium ions bind to troponin, causing a conformational change in the thin filaments of the sarcomere and enabling myosin cross-bridge formation with actin. This process leads to muscle contraction and force generation.

NEUROMUSCULAR DISORDERS

- Myasthenia Gravis
- Lambert-Eaton Myasthenic Syndrome (LEMS)
- Botulism
- Congenital Myasthenic Syndromes (CMS)

ASSESSMENT

- What is Neuromuscular Junction ?
- What all are the Functions of Neuromuscular Junction ?