

Physiology of the Motor Unit

Dr Taha Sadig Ahmed

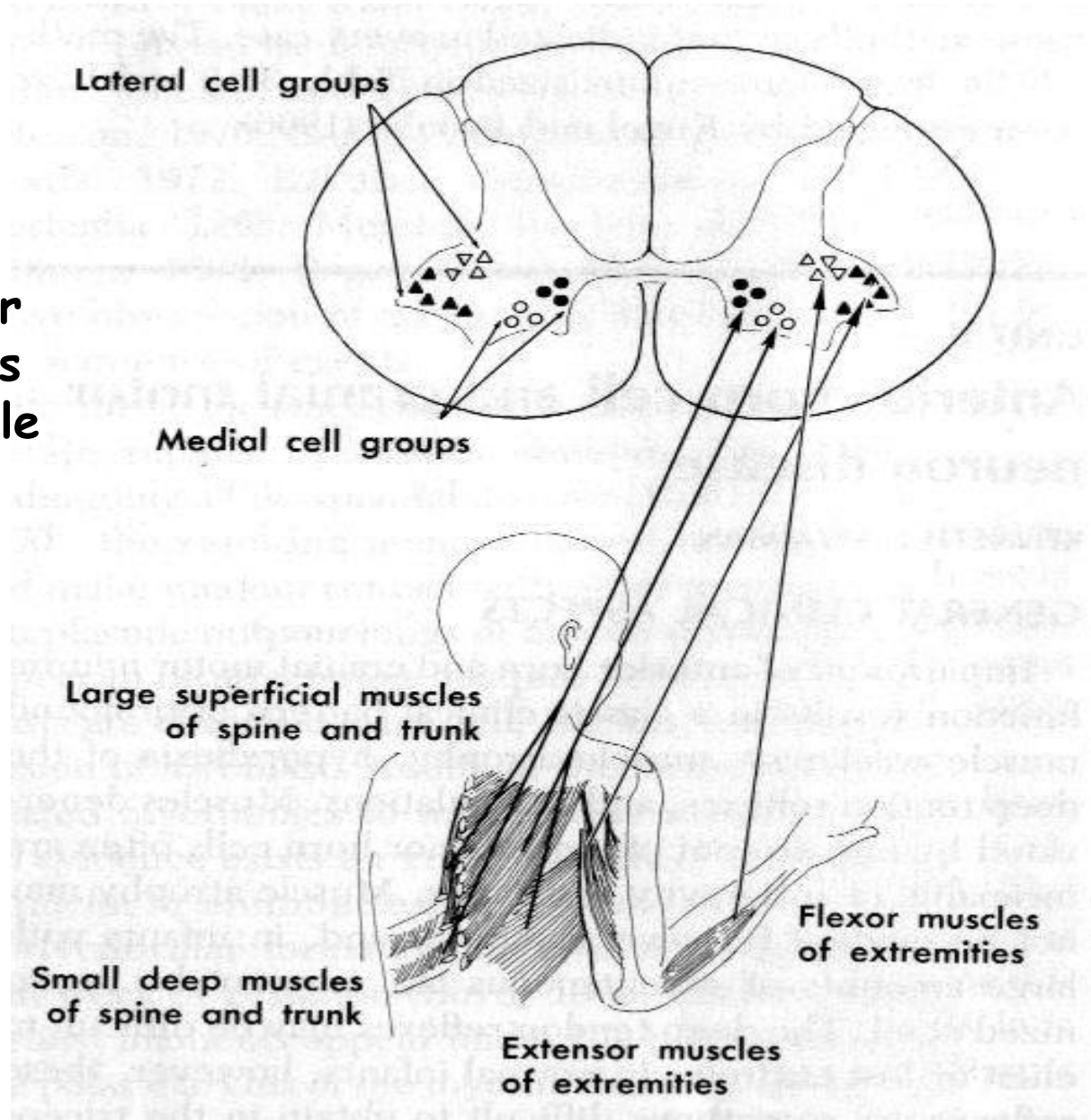
**MBBS (Medicine Bachelor and Bachelor
of Surgery, University of Khartoum ,**

PhD Clinical Physiology (England),

MANM (USA)

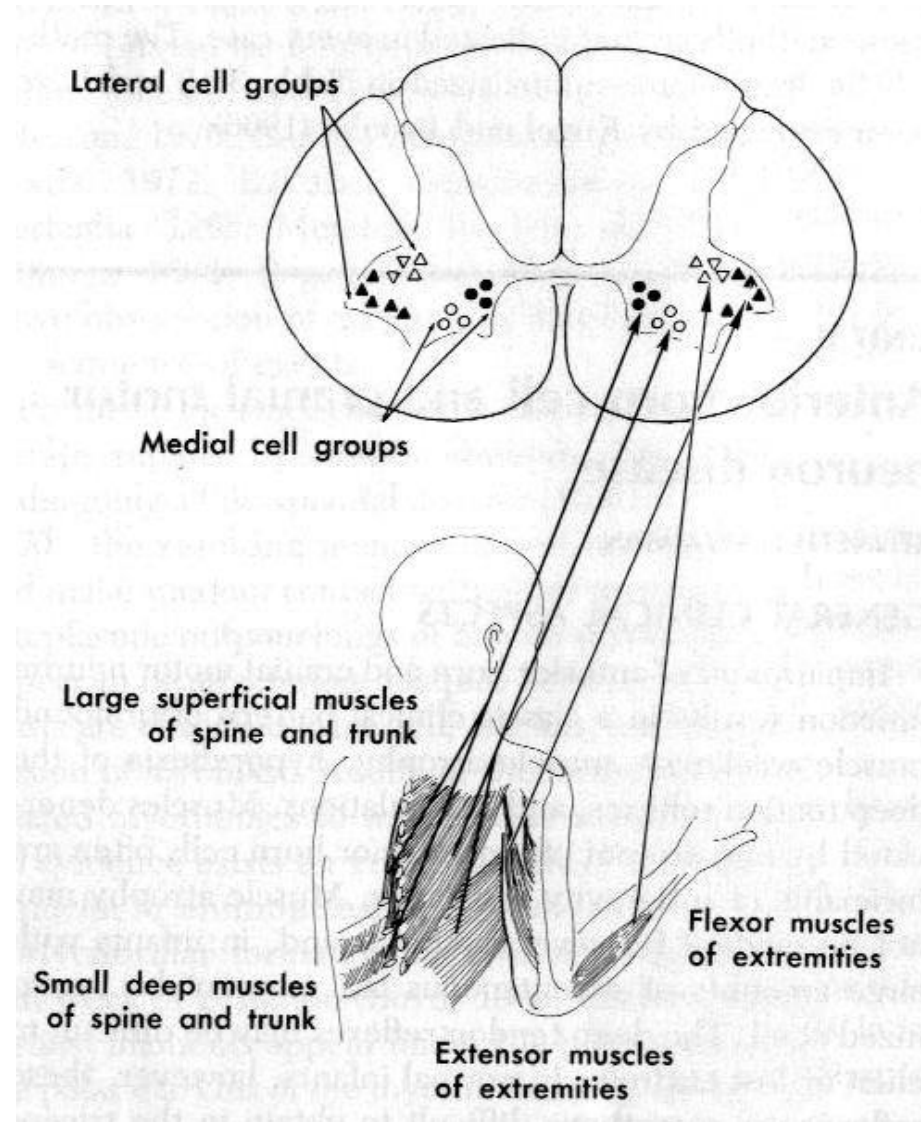
Consultant in Clinical Physiology

ماهو عصبون القرن الأمامي ؟؟ (AHC)

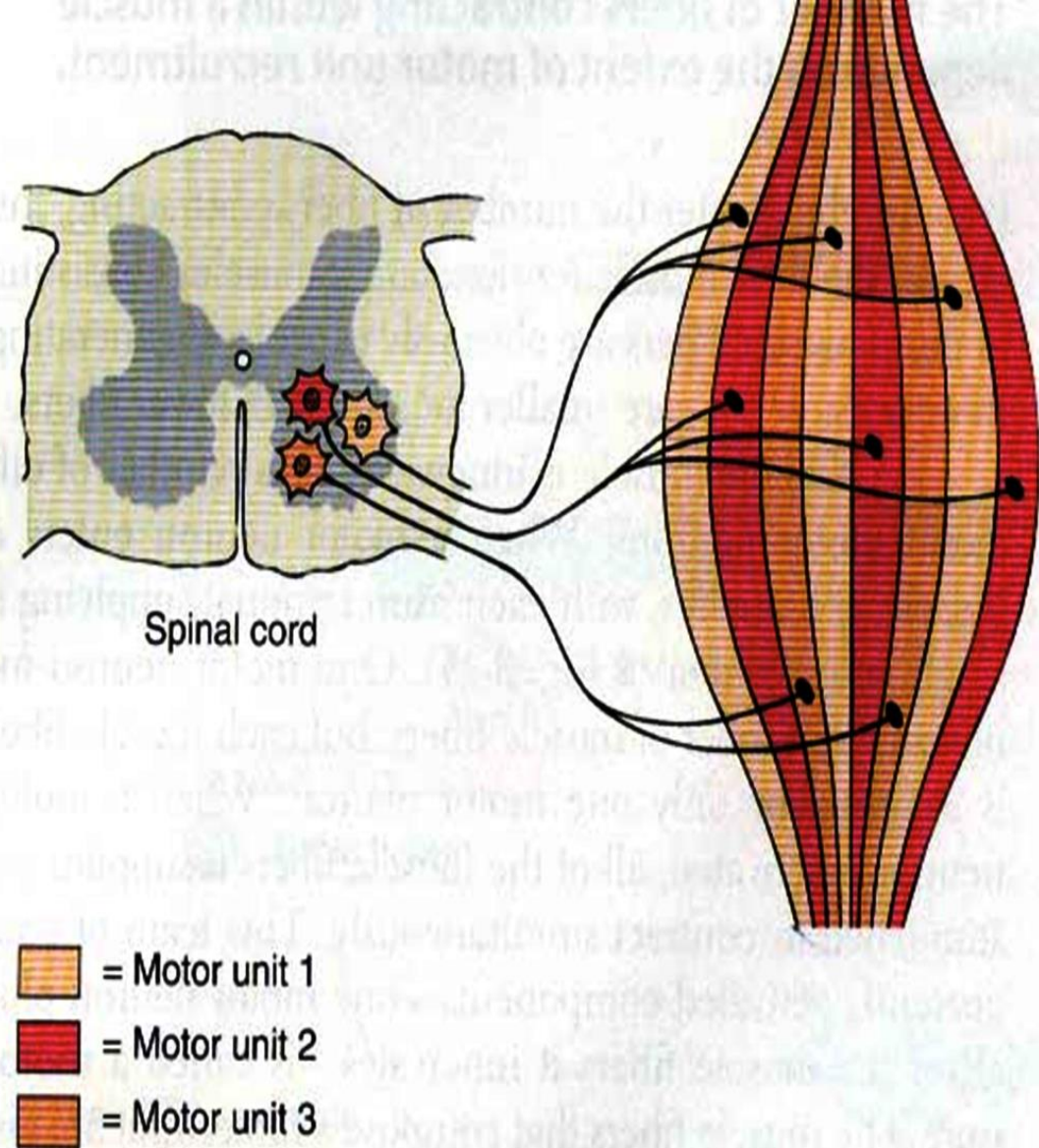


✓ AHC is the motor nerve that controls the skeletal muscle cell contraction

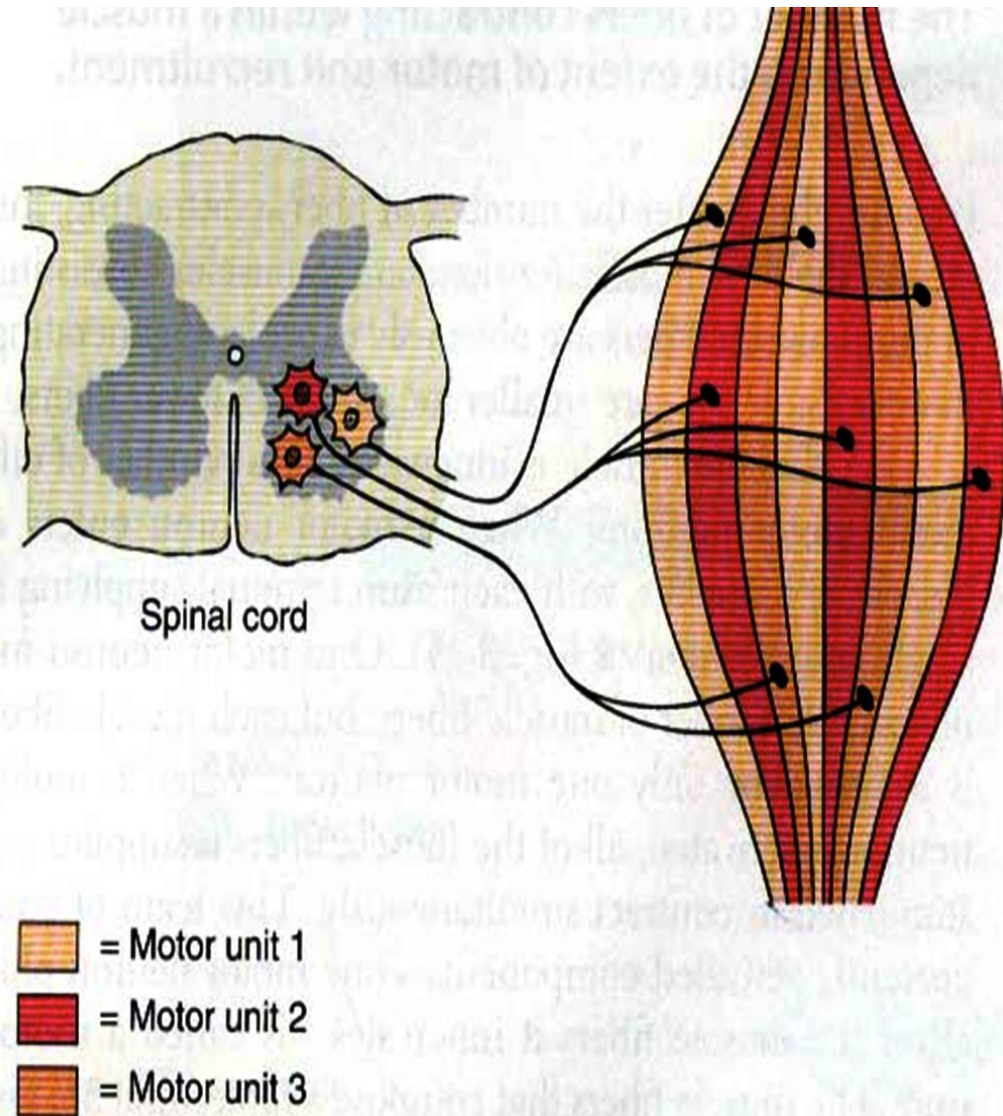
- When the axon of the motor nerve enters the muscle , it divides into many branches inside it
- The ending (terminal) of each of these branches is enlarged , contains vesicles of ACh and it supplies (innervates) only one muscle cell (muscle fiber).
- Thus each muscle cell is supplied by only one AHC .
- On the other hand, one AHC , through the branches of its axon , supplies several muscle cells .
- Q : What is the motor unit ?
• الوحدة الحركية ؟



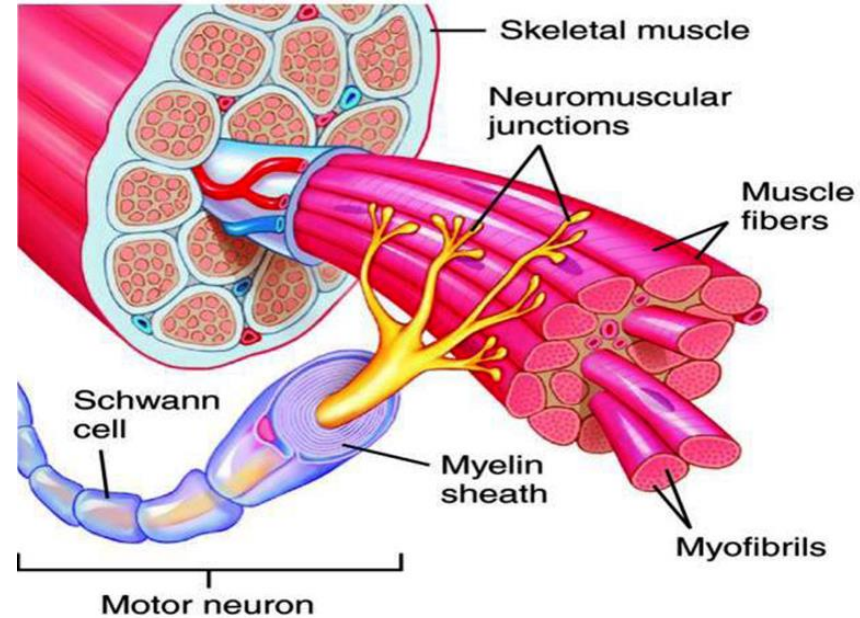
- Q:What is a Motor Unit ?
- It is the Motor Neuron (Anterior Horn Cell , AHC) and all the muscle fibers it innervates (supplies)



- Q: What is the neuromuscular junction (NMJ) ?
- It is the place where the axon terminal contacts the muscle cell
- What is the chemical transmitter released by the axon of the motor nerve ?
- It is Acetylcholine (ACh)



- Functionally speaking , muscles can be considered as being made of consist of a number of motor units
- A motor unit is the motor neuron and all muscle fibers within the muscle it innervates (supplied with it)
- All muscles consist of a number of motor units and the fibers belonging to a motor unit are dispersed and intermingle amongst fibers of other units.
- All of these fibers will be of the same type (either fast twitch or slow twitch).



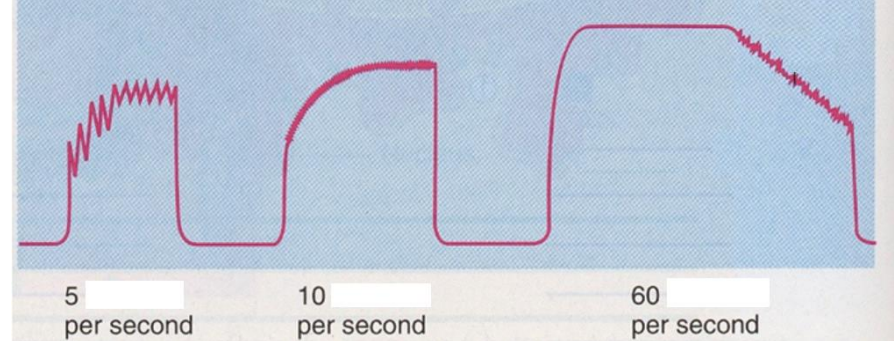
- When a motor unit is activated, all of its fibers contract.
- Groups of motor units often work together to coordinate the contractions of a single muscle
- All of the motor units that subserve a single muscle are considered a motor unit pool.

- The number of muscle fibers within each motor unit can vary →
- In general , the smaller the motor unit (i.e., the smaller the number of muscle fibers controlled by a single motor neuron in that unit) , the more accurate & precise the action of the muscle which contains that unit .
- Therefore , muscles that carry gross , big movements (e.g., muscles that mediate trunk flexion , extension , etc) have large units (many muscle fibers per one motor neuron).
- Conversely , muscles that carry fine , refined movements (e.g., eye muscles) or skilful , manipulative movements (e.g., hand muscles) or of facial expression , have small motor units containing relatively small number of muscle fibers per one AHC.

- In electrodiagnostic testing (EMG , electromyography) for a patient with weakness, careful analysis of the motor unit action potential (MUAP) size, shape, and recruitment pattern can help in distinguishing a myopathy from neuropathy.

- Motor unit recruitment

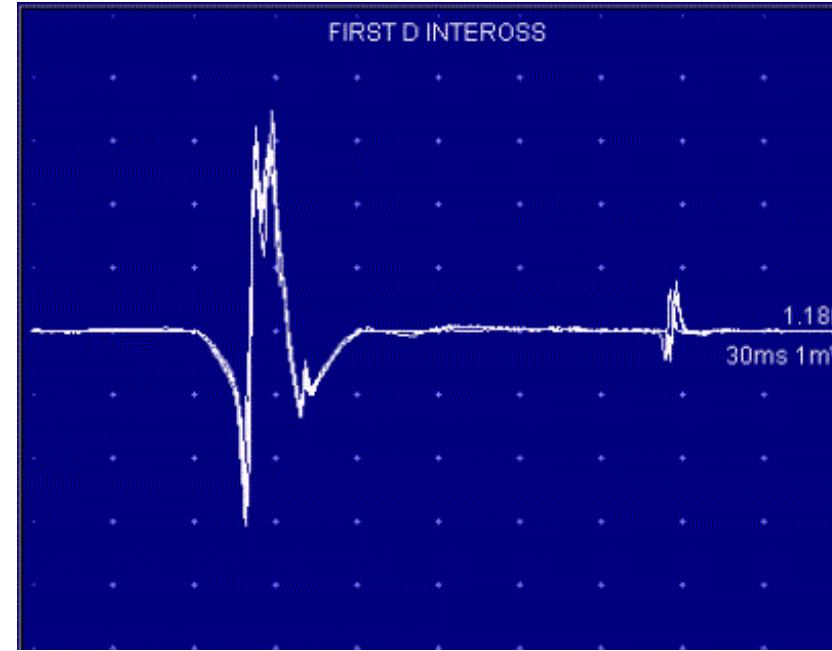
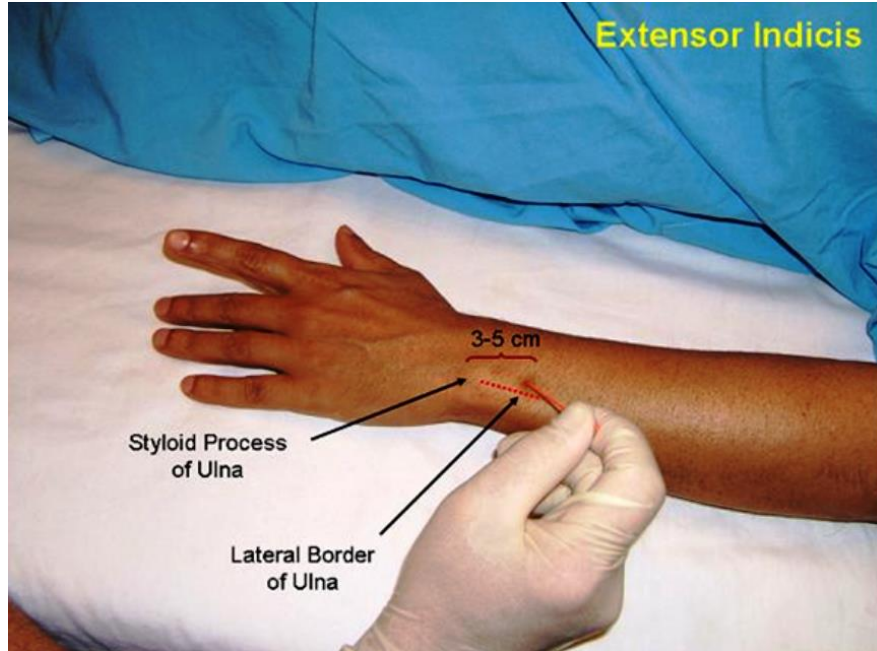
- Recruitment of motor units is the progressive activation of a muscle by successive recruitment of contractile units (motor units) to accomplish increasing degrees of contractile strength (force).
- When a motor neuron is activated, all of the muscle fibers innervated by the motor neuron are stimulated and contract.



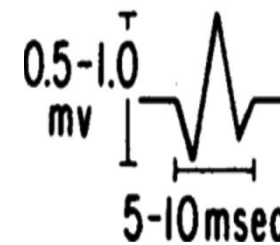
Increasing frequency of action potentials resulting in stronger force of contraction

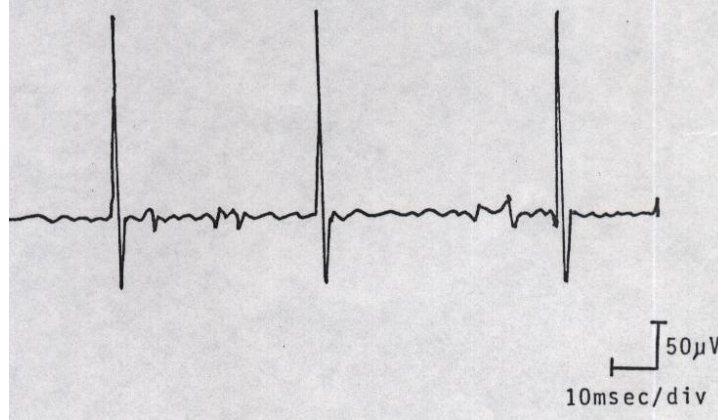
- When the AHC fires at slow rates , MUPs will be at slow rates , & the force of muscle contraction is weak .
- If AHCs fire at very fast rates → fast MUPs → stronger contraction
- At maximum effort → we get in the EMG interference pattern .

Electromyogram (EMG)

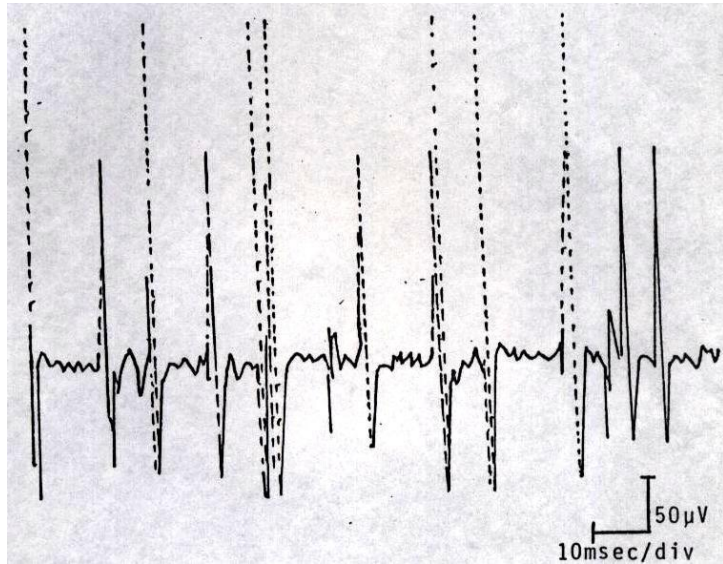


Motor Unit potentials (MUPs)

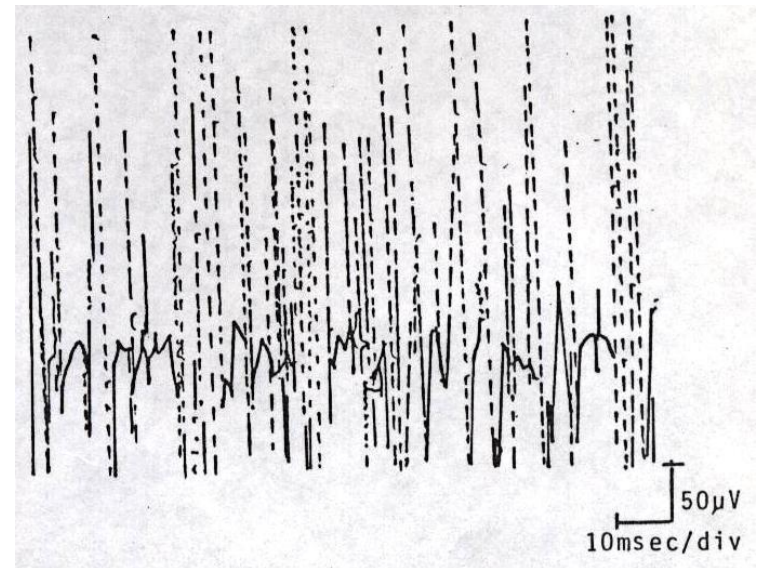




Motor Unit potentials (MUPs) During Mild Effort

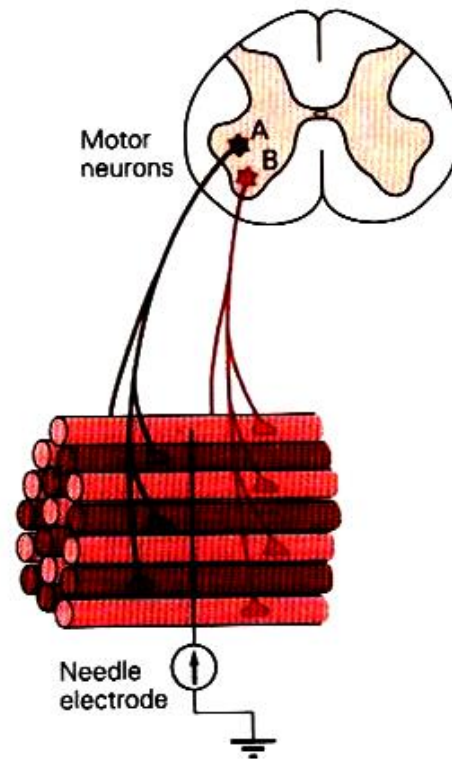


During Moderate Effort



During Maximum Voluntary Effort

- The activation of one motor neuron will result in a weak but distributed muscle contraction.
- The activation of more motor neurons will result in more muscle fibers being activated, and therefore a stronger muscle contraction.
- The higher the motor unit recruitment, the stronger the muscle contraction.
- The force produced by a single motor unit is determined by →
 - (1) the number of muscle fibers in the unit, &
 - (2) the frequency with which the muscle fibers are stimulated by their innervating axon.



- Generally, this allows a 2 to 4-fold change in force.

- Thanks